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ABSTRACT

Twelve resource units are presented for the teaching of science and mathematics to gifted students in secondary school. The units present an introduction, tips for teachers, objectives, activities, and materials lists. The units include: "Functions, Relations, and Graphs" (Priscilla Watts); "More Wham to the Gram (A Study of the Metric System)" (Mary Lindsay); "Exploring Polygons" (Marty Hearn); "How Far? How Fat? How Full? A Teaching Unit on Measurement" (Danny Seaver); "It All Depends on How You Slice It: A Study of Conic Sections" (Sherry Austin); "Our Vanishing Appalachian Environment" (Katherine McGrady); "Adapting to Life" (Malinda Jones); "The Possibility of Probability and Statistics" (Ione Collins); "Verbal Problems" (Beatrice Pickens); "Shapes in Your Life" (Nellie Pruitt); "Logical Reasoning" (Brenda Hughes); and "Going, Going, Gone?" (Sandra Ruppe). (JDD)

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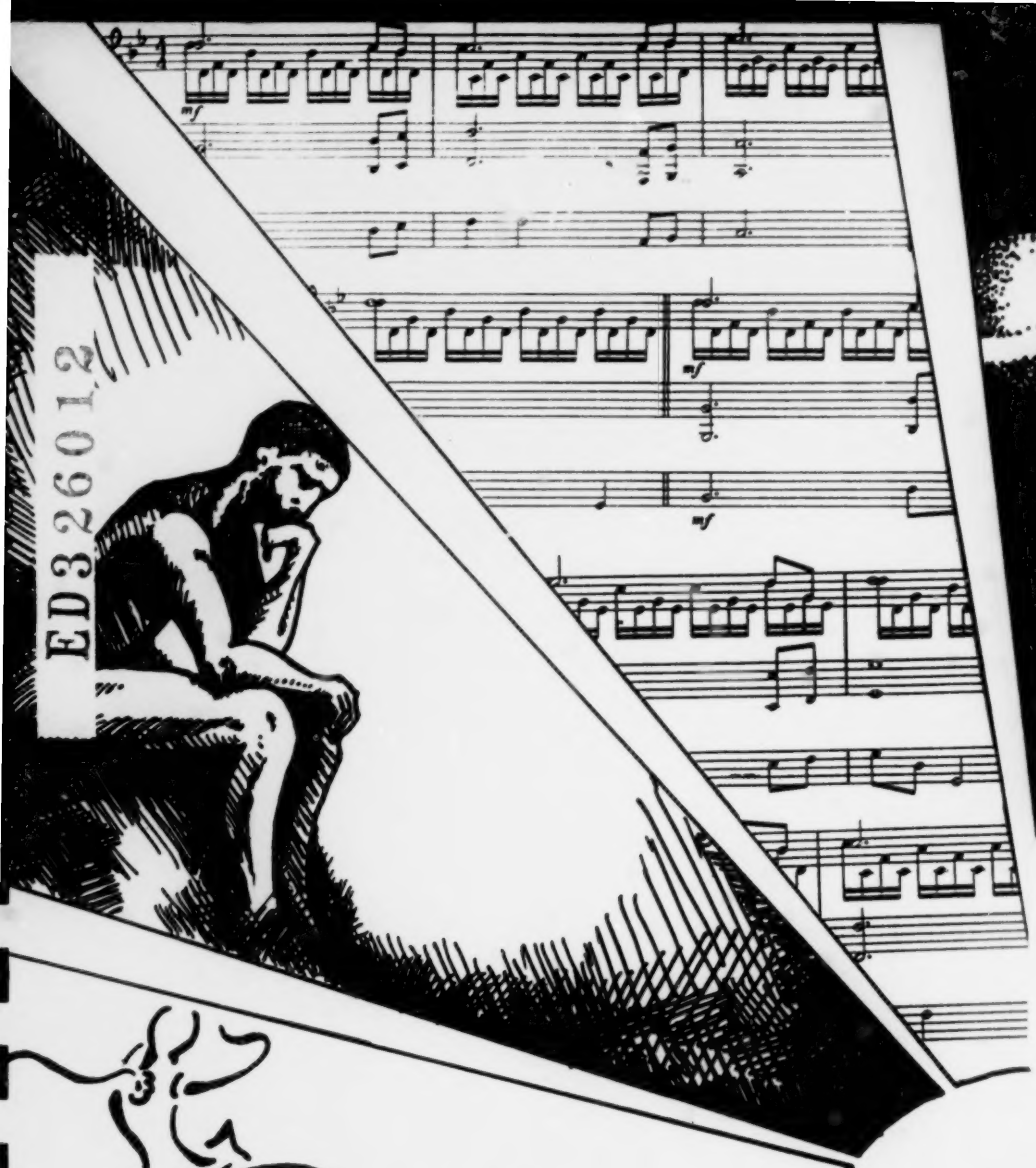
Quest for Gold

Math/Science Curriculum Resource Units for Gifted and Talented Youngsters Grades Eight - Twelve

Donald G. Hayes

Edited by
Linda B. Dockery

1989

Funded in part by The Alliance For Gifted and Talented of North Carolina, Inc.

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PREFACE

The purpose of this book is to provide teachers of academically gifted students with some "model" teaching units that, with little modification-unless desired, can be used in their exciting task of challenging bright students. A review of the teaching units will indicate that: 1) They can be used at multiple grade levels, 2) Emphasis is given to the development of critical and creative thinking skills, 3) The units are interdisciplinary and, at the same time, reflect a concern for "basis skills," important for all students to master, 4) The units can be used in a variety of settings, e.g., resource rooms, heterogeneous/homogeneous classes, 5) The units are sufficiently comprehensive to enable the user to select teaching strategies most appropriate for their situation. (While the units were originally written for use by the authors in a particular school and community and, consequently, may contain related references, this - in no way - restricts their use as all of the units are easily adaptable to any locale.)

The units were developed by practicing classroom teachers seeking endorsement (certification) to teach academically gifted students. The units were developed to satisfy a course requirement in "Methods and Materials for the Gifted," one of the academically gifted courses regularly offered at Lenoir-Rhyne College, a Lutheran-related college located in Hickory, North Carolina.

As the instructor of the very creative teachers who developed the units included in this book, I am proud of their efforts and believe the units will be of great use to teachers of academically gifted students. Also, I am grateful that the North Carolina Association for the Gifted and Talented is publishing the materials. I know of no better way for NCAGT to carry out its mission of promoting the education of academically gifted students.

Donald G. Hayes, Professor of Education
Lenoir-Rhyne College, Hickory, N. C.

ACKNOWLEDGMENTS

Dr. Donald Hayes, Professor of Education at Lenoir-Rhyne College, received his Ph.D. in Education, Philosophy, and Psychology from the University of North Carolina. He was one of the original pilot teachers for gifted children in this State and the first State Consultant of Programs for the Gifted. He then worked as Assistant Director of the Learning Institute of North Carolina conducting research on problems in learning, values formation, motivation, stress, and learning disabilities. He is a co-founder of the Governor's School, and the North Carolina Advancement School and was the founder and first director of the Learning Academy, a research and development residential school for children with learning problems. He served as Assistant Superintendent for Instruction for the Chapel Hill City Schools.

He has conducted hundreds of workshops for educators, psychologists, counselors, and parents, and authored many articles and publications on topics about learning. He is co-author of the book, "My Child is Gifted! Now, What Do I Do? another NCAGT publication.

He is active in numerous professional, church, and civic activities and is a former member of the Hickory City Board of Education. He is past President of the North Carolina Association of Colleges of Teacher Education, and he was the 1985 winner of the NCAGT Annual Award. He is married and the father of two children.

Dr. Linda Dockery, Executive Secretary of the Alliance for the Gifted and Talented of North Carolina and Personnel Administrator in Winston-Salem/Forsyth County Schools, brought her experience as both a classroom teacher and teacher facilitator to bear as she edited the assortment of units found in this volume.

Special thanks also go to John Fox, advanced placement teacher of art in the Winston-Salem/Forsyth County Schools and his student John Crutchfield, for designing the cover of this book. John Crutchfield not only is a talented artist but a gifted wrestler and a Morehead Scholar.

Thanks are also expressed to the board of Directors of The Alliance for Gifted and Talented of North Carolina, Inc. for partially funding this project and to C. Douglas Carter and the Winston-Salem/Forsyth County Schools for their continued support and encouragement.

Functions, Relations, and Graphs

Priscilla Watts

Functions, Relations, and Graphs
Priscilla Watts

Introduction

This unit will help the student to see the relationship between two variables as graphed on a coordinate plane. The activities should provide motivation for using ordered pairs of numbers. The variety of activities should provide a good understanding of the relationship between an equation and a graph. At the end of this unit, the student should understand the difference between linear and quadratic relations. The activities should help develop an appreciation of the use of both types of relations in our environment. There should be ample opportunity to practice computational and reasoning skills.

This unit is appropriate for study with the gifted and talented student because, in addition to improving thinking skills, this unit will provide the background needed for further work in higher mathematics and science. The activities should develop their ability as problem solvers.

This material is designed for use with a gifted and talented Algebra II class consisting of tenth and/or eleventh graders and should be covered in 4-5 weeks.

Tips for the Teacher

1) Two or three short quizes should be given during the teaching of this unit. This will enable the teacher to discover if the students are learning the material required-It may be necessary to reteach certain material.
2) Students should be required to keep a notebook with their assignments to be checked at the end of this unit. (There are notebooks of graph paper available.)
3) Students should be required to go to the board once during the unit to explain a problem from an assignment. After every student has gone to the board, students may volunteer for extra times at the board for extra credit.
4) Some of the activities may be assigned as extra credit. An extra grade of 100 may be averaged in for extra credit work.
5) Assignments will be made from current texts.

Objectives

1) Distinguish between a function and a relation. (C-4)
2) Graph linear equations and inequalities with two variables on a Cartesian coordinate plane. (C-3)
3) Determine the slope of a line. (C-4)
4) Graph systems of equations and inequalities in the same plane. (C-3)
5) Graph quadratic functions. (C-3)
6) Develop a formula for any given linear function. (C-3)
7) Distinguish between a linear function, a quadratic function, and a quadratic relation. (C-4)
8) Compare the equations for a line, circle, ellipse, parabola, and a hyperbola. (C-6)
9) Develop an appreciation of the uses of relations in our environment. (A-3)
10) Discover the use of quadratic relations in certain occupations. (A-5)

Objective classified according to:

Bloom's Major Categories in the Cognitive Domain of the Taxonomy of Educational Objectives (1956)

1) Knowledge
2) Comprehension
3) Application
4) Analysis
5) Synthesis
6) Evaluation

Krathwohl's Major Categories in the Affective Domain of the Taxonomy of Educational Objectives (1964)

1) Receiving
2) Responding
3) Valuing
4) Organization
5) Characterization

Introductory activities

1) Plot a given selection of points on graph paper to form a picture. (See A-1 and A-2 in appendix.)
2) Practice writing equations and inequalities in y-form
   a) $2x + y = 6$
   b) $3x + 2y = 8$
   c) $x - y = 4$
   d) $x + y < 5$
   e) $x + 2y \geq 6$
   f) $3x - y \leq 4$
3) Identify the type of relation from an equation. (Include equations for a line, circle, parabola, ellipse, and hyperbola).
4) Look in newspapers and magazines and bring in pictures of horizontal, vertical, and oblique lines; parabolas; circles; ellipses; and hyperbolas.

Developmental activities

1) Tell the domain and range of a given set of relations
   a) {(1.2)(3,4)(3,8)}
   b) $y = x + 2$
   c) $y = 4$
   d) Use graphs from graph paper (see A-3 in appendix)
2) Tell whether certain relations are functions. (Use same problems as #1)
3) Tell which quadrant or on which axis the following points lie?
   a) (2,-3) c) (0,5) e) (-2,0)
   b) (5,1) d) (-2,-1) f) (-2,6)
4) Name the slope and y-intercept from the given equations
   a) $y = 2x + 1$ b) $2x + 3y = 6$
5) Graph some linear equations
   a) $y = 2x + 1$ c) $y = 4$
   b) $x + y = 3$ d) $x - 3 = 0$
6) Graph some linear inequalities
   a) $y < 2x$ c) $y < 5$
   b) $y \geq x + 1$ d) $x \geq 3$
7) Graph some systems of equations and systems of inequalities and indicate the intersection
   a) $2x + y = 3$, $x - 2y = -1$
   b) $y \geq x - 2$, $y \leq x + 6$
   c) $-1 < x < 3$

8) State the vertex of the following parabolas using the form y = a(x-h)2 + K when the vertex is at the point (h,k).

a) y = 3(x-1)2 + 5 c) y = -2 (x - 3)2

b) y = x2 + 2 d) y = (x + 1)2 - 3

9) Use the method of completing the square to put the following equations in the form used in #8, then state the vertex.

a) $y = x^2 + 2x$

b) $y = x^2 - 4x - 12$

c) $y = 6x - x^2$

10) Graph the parabolas in #8 and #9

11) Use the discriminant, $b^2 - 4ac$, to determine

a) how many points the parabola has in common with the x-axis and

b) whether its vertex lies above, below, or on the x-axis. Use problems such as in #9.

12) Name the radius and center of the following circles and graph

a) $(x - 1)^2 + (y + 2)^2 = 16$

b) $x^2 + (y - 3)^2 = 25$

c) $(x + 2)^2 + y^2 = 4$

13) Use the method of completing the square to put the equations in the form $(x - h)^2 + (y - k)^2 = r^2$, then name the center (h,k) and radius r.

a) $x^2 + y^2 + 4x = 0$

b) $x^2 + y^2 + 2x + 4y - 4 = 0$

c) $x^2 + y^2 - 4x + 8y - 5 = 0$

14) Graph the following ellipses:

a) $x^2 + 25y^2 = 100$

b) $16x^2 + y^2 = 64$

15) Graph the following hyperbolas:

a) $x^2 - y^2 = 1$

b) $x y = 4$

16) Graph some systems of quadratic relations and name all points of intersection

a) $x^2 + y^2 = 4$ b) $x^2 + y^2 = 16$

$x y = 2$ $x^2 + y = 0$

Culminating activities

1) Write a linear equation or linear inequality from a graph. (See A-4 in appendix)

2) Write a linear equation given the slope of a line and one point

a) slope = 1/2, point (2,1)

b) slope = 0, point 95,2)

3) Write a linear equation given two points on the line

a) (2,-1) (3,2)

b) (3,5) (3,-1)

4) Pick out 2 structures in the community, identify them and identify all linear and/or quadratic relations used in the construction. (parabolas, circles, etc.)

5) Doing some research, find out specifically what occupations use graphing.

6) Draw a picture, then name the coordinates of all points used.

Evaluation activities

1) Draw a picture using quadratic relations. (See A-5 in appendix)
2) Give pre-test at the beginning of the unit. (See A-6 in appendix)
3) Give post-test at the end of the unit.
4) Check the notebook that the students were required to keep. (See Tips for the Teacher)
5) Evaluate the student's ability to explain problems to their classmates. (See Tips for the Teacher)

Materials

Ruler
Graph paper
Compass
Modern Algebra and Trigonometry; 1973;
Sorgenfrey, Wooten, Dolcian
Picture Graphing
The Math Group, Inc.
396 E. 79th St.
Minneapolis, Minn. 55420
Graph Gallery
Creative Publications, Inc.
P.O. Box 10328
Palo Alto, Calif. 94303
Palatable Plotting
Creative Publications, Inc.
P.O. Box 10328
Palo Alto, Calif. 94303

Appendix A-1

(-11,2)
(-9,1)
(-8,-1)
(-8,-5)
(-11,-8)
(-8,-7)
(-6,-7)
(-6, -10)
(-7,-9)
LINE ENDS

(-7,-8)
(-7,-10)
(-9,-9)
(-12,-10)
(-14,-10)
(-14,-9)
(-13,-7)
(-14,-8)
(-16,-4)
(-16,-1)

(-14,6)
(-12,8)
(-9,9)
(-4,9)
(2,6)
(4,3)
LINE ENDS

(-15,2)
(-17,2)
(-18,4)
(-18,5)
(-17,6)
(-16,6)
(-15,5)
(-15,4)
(-16,3)
LINE ENDS

(-16,4)
(-16,5)
(-17,4)
(-16,3)
(-15,3)

(-17,2)
(-18,1)
(-18,0)
(-19,0)
(-19,2)
(-18,3)
LINE ENDS

(5,1)
(8,-2)
(11,-5)
(13,-6)
(14,-7)
(14,-9)
(13,-10)
LINE ENDS

(10,-8)
(8,-9)
(3,-9)
(1,-10)

(16,-10)
(18,-9)
LINE ENDS

(17,-8)
(19,-10)
(19,-8)
LINE ENDS

(19,-9)
(20,-10)
(20,-7)
(18,-7)
(15,-8)
(14,-8)
LINE ENDS

(11,2)
(8,-2)
(8,4)
(13,4)
(15,0)
(8,4)
LINE ENDS

(8,-2)
(7,4)
(2,2)
(2,-3)
(7,4)
LINE ENDS

(-1,-5)
(1,-6)
(2,-7)
(2,-8)
(1,-10)
(-3,-10)
(-4,-8)
(-4,-8)
(-4,-7)
(-2,-5)
(-1,-5)
(1,-7)
(1,-8)
(0,-10)
LINE ENDS

(2,-7)
(5,-7)
(6,-8)
LINE ENDS

(3,-7)
(4,-8)
LINE ENDS

(5,-5)
(5,-6)
(6,-6)
(7,-5)
LINE ENDS

(8,-5)
(8,-6)
(9,-6)
(10,-5)
LINE ENDS

* (-3,-7)
(-2,-7)
(-2,-8)
(-3,-8)
(-3,-7)
LINE ENDS

* (-1,-7)
(0,-7)
(0,-8)
(-1,-8)
(-1,-7)
LINE ENDS

*Shade these areas.

A-2

Plot the following points on a single set of coordinate axes, then connect the points with segments between consecutive points to form four closed figures. Place the coordinate axes in the center of your graph paper, in order to accommodate the completed figure.

I
1. (-0.5, -7.5)
2. (-0.5, -8.5)
3. (3.5, -8)
4. (3.5, -7)

II
1. (-4.5, 1.5)
2. (-2.5, 1.5)
3. (-2.5, 0)
4. (-4.5, 0)

III
1. (-1.5, -10)
2. (-5, -7)
3. (-5, -9.5)
4. (-1.5, -7)

IV
1. (-9.5, 14)
2. (-8.5, 10)
3. (-6, 6)
4. (-4.5, 5)
5. (-1, 3.5)
6. (-4, 2.5)
7. (-6.5, .5)
8. (-7, -1.5)
9. (-6.5, -3)
10. (-3, -5)
11. (-3, -7)
12. (-0.5, -5.5)
13. (-0.5, -7)
14. (3.5, -5.5)
15. (4.5, -2.5)
16. (4.5, 0.5)
17. (3, 3)
18. (6, 6)
19. (6, 14)
20. (2, 10)
21. (1.5, 6)
22. (1.5, 3.5)
23. (-3, 9)
24. (-6.5, 12)

A-5
Bucket

$y = -4x - 28 : -4 < y < 4$

$y + 4x + 28 = 0 : |y| < 4$

$\begin{cases} y - 12 = -8(x + 3)^2 \\ y > x + 7 \end{cases}$

$\begin{cases} 8x^2 + y + 48x + 60 = 0 \\ x - y + 7 < 0 \end{cases}$

$y = 12 \text{ or } y = 8 : x > 3$

$(y - 12)(y - 8) = 0 : x > 3$

$\frac{(x + 3)^2}{9} + \frac{(y + 4)^2}{1} = 1 : y < -4$

$\begin{cases} x^2 + 6x + 9y^2 + 72y + 144 = 0 \\ y + 4 < 0 \end{cases}$

$\frac{(x + 3)^2}{25} + \frac{(y - 4)^2}{1} = 1$

$x^2 + 6x + 25y^2 + 384 = 200y$

$y = 4x - 4 : -4 < y < 4$

$y + 4 = 4x : |y| < 4$

$\begin{cases} y - 10 \leq -1/2 (x - 3)^2 \\ y - 8 \geq -(x - 3)^2 \\ y > 7/2 \\ y > 4x - 4 \end{cases}$

$\begin{cases} 2y \leq -x^2 + 6x + 11 \\ y + x^2 \geq 6x - 1 \\ 2y > 7 \\ 4x < y + 4 \end{cases}$

$16x^2 - 96x + y^2 - 20y + 240 = 0$

$\frac{(x-3)^2}{.25} + \frac{(y-10)^2}{4} = 1$

$\frac{(x+3)^2}{25} + \frac{(y-4)^2}{1} \leq 1$

$\frac{(x+3)^2}{16} + \frac{(y-3)^2}{1} \leq 1$

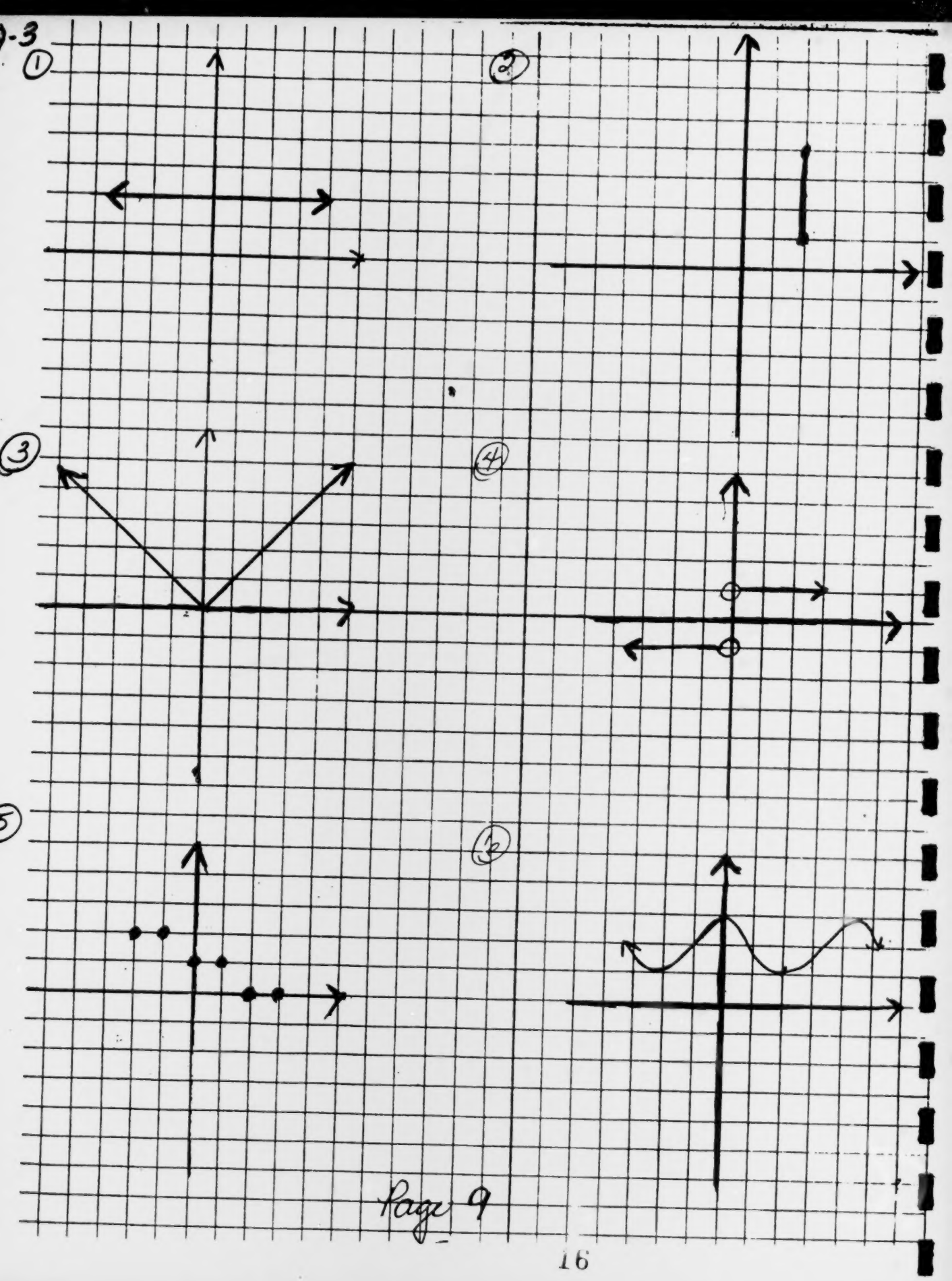
$\begin{cases} x^2 + 25y^2 \leq 200y - 6x - 384 \\ x^2 + 6x + 16y^2 - 96y + 137 \leq 0 \end{cases}$

A-6

Pre - Test

1) In which quadrant would you locate?
   a) (3,-5) b) (2,8)
2) Write in y-form
   a) $x + 2y = 8$ b) $2x - y < 6$
3) Identify the type of relation
   a) $x + 2y = 4$ d) $x^2 - 4y^2 = 1$
   b) $x^2 + y^2 = 4$ e) $x^2 + 16y^2 = 16$
   c) $y = x^2$
4) Give the domain and range
   a) { (2,1) (3,6) (4.6) }
   b) $x = 3$
5) Name the slope and y-intercept
   a) $y = 3x$ b) $x + y = 4$
6) Name the vertex:
   a) $y = x^2$ b) $y = (x - 2)^2 - 1$
7) Name the radius and center
   a) $x^2 + y^2 = 4$ b) $(x - 1)^2 + (y + 2)^2 = 9$
8) Write an equation for a line passing through (2,3) and (3,6)

0-3



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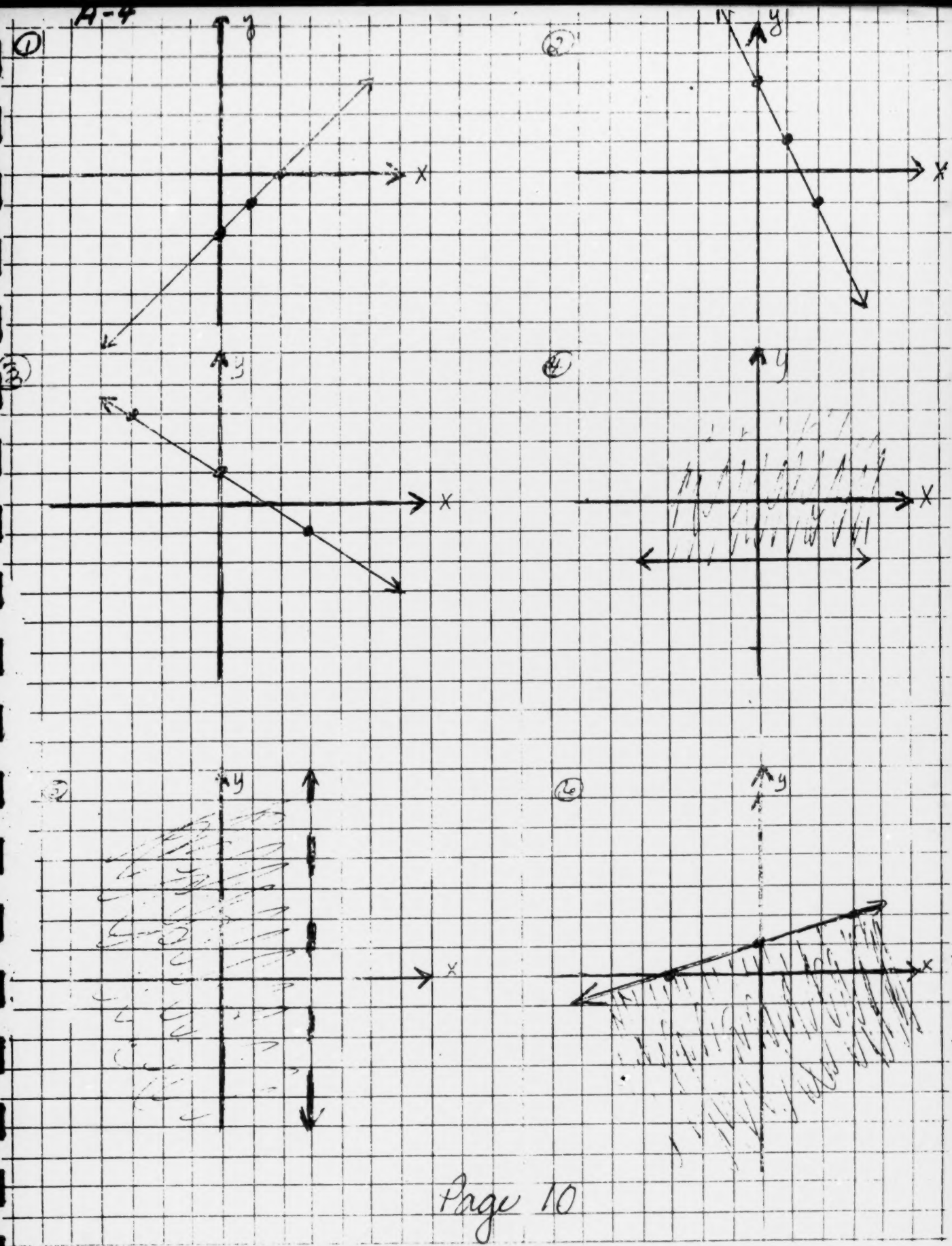
A-4



Page 10

More Wham to the Gram
(A Study of the Metric System)

Mary Lindsay

More Wham to the Gram
(A Study of the Metric System)

There once was a student named Peter
Who asked, "Why use meter and liter?"
But when he found out
He let out a shout
"Cause meter and liter are NEATER"

Mary Lindsay

MORE WHAM TO THE GRAM
A Study of the Metric System
Mary Lindsay

I. Introduction

This unit is a study of the International System of Measures (here-after known as the metric system or SI), its development, its use in present society, and its potential for use. The unit is to be used as a two-week study with gifted and talented students at the secondary school level. The assumption is made that these students have been previously introduced to the metric system of measure but may not have "accepted" this system of measure as their own. The knowledge and acceptance of the SI system is important to the G.T. student for several reasons:

1. The student as a world citizen will be using the metric system as his primary system of measure.

2. The G.T. students will become leaders in political, business, and scientific fields and, hence, will provide leadership in the change from the English to the metric system of measure.

3. Many G.T. students will find careers in technical areas where the metric system is already the primary system of measure.

II. Teacher Tips

1. Have available as many metric measuring tools as possible. These should include meter stick, scales, mass weights, graduated cylinders, and a Celius thermometer.

2. Students should keep a notebook of all activities, question responses, etc. during the course of the unit since much of this information is used in the cumulative activities.

3. Note that this unit does not emphasize metric/English conversion but rather the ability to think metric!

4. Note that answer keys for the Pre/Post Test and the Mixed Measure Activity are included in Appendix F.

5. Developmental Activity #8 can be done most readily by dividing the class into three groups to do the actual measurements.

6. Materials needed for Developmental Activity #10 include a hot plate, ice cream freezer, ice, and salt. Students may be assigned recipe ingredients.

7. Note that some activities are included which may be used as exercises in other mathematical units throughout the year.

III. Objectives

At the conclusion of this unit, the student will be able to:

1. State the SI units for length, mass, volume, and temperature. State metric measure prefixes, their abbreviations, and values.

2. Measure length, mass, volume, and temperature in SI units.

3. Define the relationship between the SI units of length, mass, and volume.

4. Estimate metric measures for a given item, e.g., 70C = __?__ F.

5. Compare the historical development of the English measure to metric measure.

6. Justify the change from the use of English measure to metric measure.

7. Integrate metric measures into algebraic and geometric verbal problems.

IV. Activities

A. Introductory

1. Work in pairs to develop a system of linear measure using some item in the classroom as a basic unit. Use the system to measure.
   a. the length of the classroom wall.
   b. a piece of chalk.

   Discuss the disadvantages of making this a universal system. Share these in a classroom discussion.

2. Pretest - Measure previous knowledge of terms, prefixes, abbreviations, and ability to estimate (Appendix A).

3. View film, Metres, Liters, and Grams, which gives a brief history of measuring systems and an introduction to the advantages of the metric system. A discussion of this film will provide basic review of facts.

B. Developmental

1. The student will be given a metric worksheet to be completed in his own time frame over the course of the unit (Appendix B).

2. The student will be given a set of "game" handouts to be completed over the course of the unit. After completing these activities, the student will create his own metric game, puzzle, or activity that would be appropriate for use in a class of students who know only basic math skills (Appendices C, D, and E).

3. The student will compare the historical development of the metric and English systems of measure. The class will discuss (1) how the manner in which each system developed affected the organization of each system, (2) the strengths and weaknesses of each system, and (3) how metrification will affect business, industry, and the individual, and (4) the original goal was complete metrification in the United States by 1984. Will we make it? What has happened since 1970 in the move toward metrification in the United States?

4. The student will interview a businessman or tradesperson who uses measures. Discuss (1) types of measuring instruments used, (2) accuracy, and (3) the effects of the change from the English to metric measure has or will have on his/her situation.

5. The student should discuss individually with his father, mother, and grandparents, if available, their feelings toward a total conversion to metric measure and how this will affect their individual lives. Compare and contrast their feelings and attitudes. What factors affect these attitudes and their differences?

6. What obligation do we (as a nation and individuals) have to conform to the international system of measures? Should a change from one system of measure to another be legislated or voluntary? What role does "big business" play in decisions (legislative and otherwise) to make changes such as that of a measuring system? The student should do some reading on these topics and relate his ideas in a class discussion.

7. If the United States were to halt its conversion to the metric system, how would the role we play in the world community be affected? Example: Will the sale of American-made car abroad be affected because of parts and tools for repair?

8. The student will keep a measure journal for one day, using only metric measurements on this day. Observe the accuracy of the measures that are used. How would a complete change to metric affect an "ordinary citizen for an ordinary day?" If you had a French foreign exchange student coming to live in your home, what are the major measuring hurdles he would have to face? Prepare a "measuring book" to give to this student to

help him to adjust. Example: How do you interpret speed limits?

9. Consider the metric prefixes as a geometric sequence. Develop a formula to find the nth term of the sequence. Develop a means of changing from one form of a metric unit to a larger or smaller form of the same unit.

10. Find the perimeter of a given tangram puzzle (A-F) and determine if the perimeter changes as you change the shape of the figure using all pieces of the tangram. How many polygons can be formed with the seven tangram pieces. Does the property of convexity affect the perimeter? Generalize a statement relating the change in perimeter to the change in shape.

11. Relate metric measures to sports.
    A. Measure baselines on a ball diamond. What is the most efficient way of making this measurement?
        1. How far in metric units would you have to run if you hit a home run?
        2. How far in metric units would you have to hit a ball to hit a metric home run at the local ball field?
    B. Measure the basketball court. What is an efficient method of making this measure?
        1. What is the metric area of the court?
        2. How far in metric units would you have to run if you ran 20 laps around the perimeter during practice?
    C. Measure your football playing field. What is an efficient way of making this measure?
        1. What is the area of the football playing field?
        2. What would you recommend for a metric football field?

    Discuss the question, "Since all international sports are metric, will metrification affect American sports?" Set up and carry out a metric track meet or metric "olympics" for the class or a P.E. class in the school.

12. Use adding machine tape or butcher paper to make a strip about 70 cm long and 5-7 cm wide. Find the area and perimeter of the strip. Connect the ends of the paper with a half-twist to form a moebius strip. Draw a line down the center of the strip. What happened? Predict what will happen when you cut on the line. Cut; then find the area of the resulting piece or pieces in square centimeters. Find perimeter. Predict what the results will be if you cut a second time, third time, fourth time. Do some research to find general information about the field of topology and the moebius strip in particular.

13. Make the following predictions:
    A. If you have a cube 1 cm x 1 cm x 1 cm, how much sand will it hold?
    B. If you have a cube with edge measure of 2 cm, how much sand will it hold?
    C. If you have a cube with edge measure of 3 cm, how much sand will it hold?

    After making the predictions, construct containers and check their volume by filling each container with sand, then pouring the sand into a graduated cylinder. What will happen to the volume of a container if you double only one side? double two sides? Generalize a formula to show how a change in the measure of a side affects the volume of a rectangular solid.
14. Bring the following ingredients and mix in class. Measure temperature at the completion of each numbered step.

    Vanilla ice cream

    10 g cornstarch)
    75 g sugar)
    10 ml vanilla)
    2 egg yolk)
    10 ml milk)
    420 ml milk)

    1. Blend cornstarch, sugar, egg yolks, and 10 ml milk.
    2. Bring 420 ml milk to boil.
    3. Remove from heat and stir in cornstarch mixture.
    4. Bring to boil again and cook for a few seconds. Leave to cool, stirring frequently. Pour into freezer container.

    While ice cream mixture is cooling, place thermometer in pan of ice water. Record temperature; 10 minutes later record temperature again. Stir in cup of salt. Record temperature every minute until no change for three minutes. Graph results. Relate this experiment to how ice cream is made in a freezer. Freeze ice cream mixture and eat! (How many times must this recipe be repeated to allow each class member a .1 kg serving?) Look up the history of the Fahrenheit experiment that led to the development of the thermometer.
15. Construct a device that will accurately weigh objects that have a mass of 5 decigrams. Determine the accuracy of your balance. What factors influence this accuracy? For what practical purposes could your balance be used? How would its use be limited?
16. Given a set of word problems (these can be selected from the student text or from a text used by the student the previous year), rewrite the problems using only metric units. Determine the unit from the answer that should be given. Example: cm, mm, l, dl, etc. show a sample solution for each problem.

C. Culminating Activities

1. Debate: Resolved - The United States should not convert to metric measure. Students will use as resources information they have ascertained through Development Activities 3, 4, 5, 6, 7, and 10.

2. Games, puzzles, and activities developed for Activity #2 will be collected and reproduced for the entire class. Following class evaluation of these for accuracy and useability, selected items will be distributed in booklet form to teachers of basic math classes in the school to be used in teaching a metric unit.

3. Class will orally review worksheet (Appendix B) and discuss any questions or problems.

V. Evaluation

1. Posttest (A-A).

2. Class will be divided in half with one half creating a metric crossword puzzle and the other half creating a metric cross-number puzzle. Two copies will be made of each puzzle. Student will be evaluated on (1) his puzzle construction, and (2) his completion of one crossword puzzle and one cross-number puzzle not his own.

3. Student evaluation of creative activities made for culminating Activity #2.

4. Teacher will evaluate individual participation in class debate either as a debater and/or contributor of information in preparation of the debate.

5. Teacher will evaluate attitude and interest as evidenced by the metric journal (Activity #3), participation in class activities (#11 and #14), and participation in discussions.

VI. Bibliography

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4. Odom, Jeffrey V. Successful Experiences in Teaching Metric. Washington, D.C.: U.S. Department of Standards, 1976.

5. Silvia and Wheeler. The Metrics World. A Survival Guide. St. Paul: West Publishing Company, 1975.

6. Metres, Litres, and Grams. G.M. Corporation, 1975. Metric film, 11 minutes.

Appendix A

Pretest/Posttest

A Metric Mastery Test

1. The _____ is the basic unit for measuring length in the metric system.
2. The _____ is the basic unit for measuring mass in the metric system.
3. The _____ is the unit for measuring capacity in the metric system.
4. The _____ is used to measure temperature in the metric system.
5. To measure volume the answer would be expressed in _____ meters, _____ centimeters, etc.
6. To measure area the answer would be expressed in _____ meters, _____ centimeters, etc.
7. In the metric system each unit of length is _____ times the next smaller unit.
8. Write the symbol for;
   a. meter _____
   b. kilometer _____
   c. centimeter _____
   d. millimeter _____
   e. liter _____
   f. gram _____
   g. Celsius _____
   h. cubic centimeter _____
9. What does the symbol m^2 stand for? _____
10. Five cm^3 is the same as _____ mm^3.

11. Write in the unit you would use to measure the following:
    a. container of milk _____
    b. a beef roast _____
    c. a length of rope _____
    d. a truckload of sugar beets _____
    e. a zipper _____
    f. a lawn _____
    g. room temperature _____
    h. electricity used _____
12. Match the approximate mass with the object.

_____ a. 50 ml of water	1. 2 kg
_____ b. a nickel	2. 80 kg
_____ c. a grown man	3. 50 g
_____ d. a small bag of sugar	4. 5 g
_____ e. a large car	5. 2 t

From: Activities Handbook for Teaching the Metric System.

13. Match the event with the most appropriate temperature.

_____ a. water freezes	1. 100°C
_____ b. a comfortable room	2. 37°C
_____ c. water boils	3. 0°C
_____ d. a cake bakes	4. 21°C
_____ e. normal body temperature	5. 160°C

14. Complete the following:
    a. 1.6 m = _____ km = _____ cm
    b. 0.4 cm = _____ m = _____ mm
    c. 5 cm^3 = _____ mm^3 = _____ m^3
    d. 260 g = _____ kg
    e. 22.4 l = _____ ml
    f. 1 m^3 = _____ cm^3 = _____ mm^3
    g. 2.2 kg = _____ g = _____ mg
15. List an approximate customary system relationship for each of the following:
    a. A meter is _____
    b. A kilogram is _____
    c. A liter is _____
    d. A centimeter is _____
16. Five g of water is about ____ ml = ____ cm^3

Appendix B

Worksheet -- Metric System

Directions - Complete each of the following. Show all work.

1. 100 cm = _____ m
2. 35 cm = _____ m
3. 1 m = _____ mm
4. 300 m = _____ cm
5. 1 kg = _____ g
6. 400 g = _____ kg
7. 1500 g = _____ kg
8. 1 ℓ = _____ mℓ
9. 900 mℓ = _____ ℓ
10. 500 mℓ = _____ ℓ
11. 5 hℓ = _____ ℓ
12. 6 Mg = _____ µg
13. 25 dℓ = _____ mℓ
14. 95 dag = _____ kg
15. 2 kg = _____ dag
16. 5 kg = _____ mg
17. 85 km = _____ hm
18. 5 dℓ = _____ ℓ
19. 12 daℓ = _____ ℓ
20. 80 kℓ = _____ µℓ

21. Briefly discuss the origin and interrelationship of the basic metric units of length, mass, and volume.

22 - 29. **Match each prefix on the left with its meaning on the right by writing the letter of the prefix in the blank in front of the meaning.**

a. mega-	_____	22.	.000001
b. micro-	_____	23.	.001
c. centi-	_____	24.	.01
d. milli-	_____	25.	.1
e. hecto-	_____	26.	10
f. kilo-	_____	27.	100
g. deka-	_____	28.	1,000
h. deci-	_____	29.	1,000,000

30. Which is more economical, the item in column I or that in column II?

	I	II
a.	2ℓ of milk for $1.02	500 ml of milk for $0.28
b.	400 g of butter for $0.89	1 kg of butter for $1.98
c.	1 kg of detergent for $1.72	1.4 kg of detergent for $2.45
d.	3 m of material for $5.38	250 cm of material for $3.89
e.	1.4ℓ of fruit juice for 63¢	0.8ℓ for $0.35

31. 7 km = _____ cm = _____dam = _____mm

32. 4308 cℓ = _____hℓ = _____mℓ = _____ℓ

33. 642 g = _____cg = _____kg = _____dg

34. 7.5 mm = _____m = _____cm = _____km

35. 9.08 mℓ = _____dℓ = _____cℓ = _____daℓ

36. 444 hg = _____g = _____dg = _____kg

37. 0.004 km = _____cm = _____hm = _____mm

38. 99.977 mℓ = _____ℓ = _____cℓ = _____dℓ

39. 72.475 dg = _____g = _____mg = _____cg

_____ 40. The SI base unit for length is:

a. kilometre b. square metre c. metre d. centimetre

_____ 41. The SI base unit for mass is:

a. gram b. kilogram c. newton d. candela

_____ 42. The prefix centi means:

a. 0.1 b. 0.01 c. 0.001 d. 0.0001

_____ 43. One hectogram is equal to 0.1:

a. kilogram b. dekagrams c. grams d. megagrams

_____ 44. A metric ton is equal to:

a. 1,000 grams b. 100 kilograms c. 1,000,000 grams d. 1,000 kilogram

_____ 45. Two kilometres is equal to:

a. 2,000,000 hectometres b. 20 dekametres c. 20 hectometres d. 200 metre

_____ 46. On the metric scale, water boils at:

a. 212° b. 100° c. 110° d. 200°

47. The derived unit of measure for volume is:

a. cubic metre b. metre c. square centimetre d. cubic litre

48. Another name for the litre is:

a. cubic metre b. cubic centimetre c. cubic millimetre d. cubic decimetre

49. Another name for the millilitre is:

a. cubic metre b. cubic centimetre c. cubic millimetre d. cubic decimetre

50. One cubic metre is equal to:

a. one cubic decimetre b. ten cubic decimetres
c. 100 cubic decimetres d. 1,000 cubic decimetres

51. The mass of one litre of cold pure water is equal to:

a. one kilogram b. 100 grams c. 10,000 grams d. one dekagram

52. One hectare is equal to:

a. 1000 m^2 b. 10,000 m^2 c. 1 dam^2 d. 250 acres

53. Farrah Fawcett-Majors would probably weigh about:

a. 50 kg b. 500 kg c. 23 kg d. 100,000 g

54. Wilt Chamberlain's height is approximately:

a. 210 cm b. 1 m c. 400 cm d. 1 km

55. Appalachian State University is about 48 km away. If you can average 96 km/h, how long would it take to drive to ASU?

a. 30 minutes b. 2 hours c. 15 minutes d. you would never get there

56. In metric terms, a pint of milk would measure about:

a. 1 litre b. 0.5 litres c. 1 kilolitre d. 0.05 litres

57. Ten gallons of gatorade would be equal to about:

a. 10 litres b. 100 litres c. 40 litres d. 40 dekalitres

58. If the temperature outside is 35°C, then I most probably would be:

a. swimming b. freezing to death c. shoveling snow d. wearing a sweater

59. The volume of a fish tank that measures 1 m x 50 cm x 390 mm is:

a. 195,000,000 cm^3 b. 195,000 mm^3 c. 19.5 litres d. 195,000 cm^3

True-False

_____ 60. One cubic metre = 1,000,000 cm^3

_____ 61. One are = 100 m^2

_____ 62. The square mm fits into the square cm 100 times.

_____ 63. A megagram is the same as a metric ton.

_____ 64. A microgram is 0.0001 of a gram.

_____ 65. One cm^3 = One centilitre

_____ 66. Five kilograms would equal approximately 11 pounds.

_____ 67. 32° on the Celsius scale is the same as 0° on the Fahrenheit scale.

_____ 68. An average two-month-old baby would measure about 55 cm in length.

_____ 69. The area of a city block 60 m x 190 m would be 1140 m^2.

Appendix C

A Magic Square*

$7\ kg = __\ mg$ $\bigcirc^{\ }$	$20\,000\ g = __\ kg$ $\bigcirc^{\ }$	$0.5\ t = __\ mg$ $\bigcirc^{\ }$
$46\ t = __\ g$ $\bigcirc^{\ }$	$0.1\ t = __\ g$ $\bigcirc^{\ }$	$4\ kg = __\ g$ $\bigcirc^{\ }$
$0.25\ kg = __\ g$ $\bigcirc^{\ }$	$1\ t = __\ mg$ $\bigcirc^{\ }$	$25\ kg = __\ g$ $\bigcirc^{\ }$

1. Work the problems in the square and express the answer in scientific notation.
2. Place the exponent in the circle.
3. Find the sum of the exponents in each row, column, and diagonal.
4. If the sums are all the same, the square is magic.

Do some research on magic squares. Try to develop rules for making up a magic square. Test your rules by constructing a metric magic square.

*From: Activities Handbook for Teaching the Metric System

Appendix D

Code Problem

DIRECTIONS

1. "Why did the man throw away his electric toothbrush?" To find the answer decode the message.
2. Work the problems and then place the letter on the correct blank.

__	_____	____	___	_____	_____
61	929114	6381	311	171541025	4121246

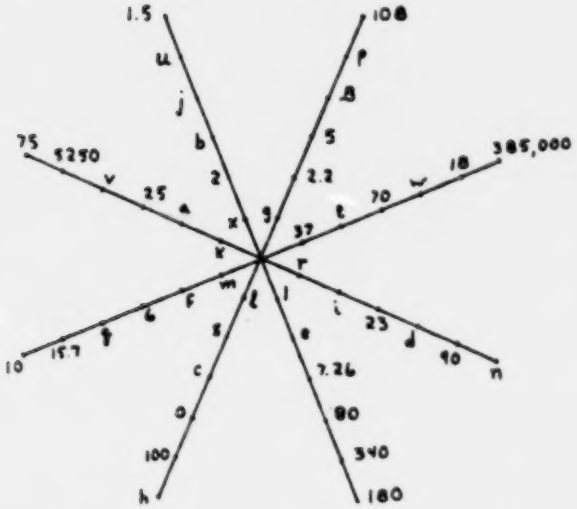
1. 300 g + 0.1 kg = _____ g
2. 300 g + 0.1 kg = _____ kg
3. 1.2 kg + 800 g = _____ g
4. 1.2 kg + 800 g = _____ kg
5. 0.5 t + 500 kg = _____ kg
6. 0.5 t + 500 kg = _____ t
7. 0.25 t + 250 kg = _____ kg
8. 0.25 t + 250 kg = _____ t
9. 2000 g + 1.7 kg = _____ g
10. 2000 g + 1.7 kg = _____ kg
11. 2.5 g + 3.5 g = _____ g
12. 500 mg + 500 mg = _____ g

A = 2000 g
C = 1000 kg
D = 3700 g
E = 400 g
H = 1 t
I = 0.4 kg
L = 500 kg
N = 6 g
O = 1 g
R = 3.7 kg
T = 2 kg
V = 0.5 t

1. In how many ways can mass measurement be expressed?

2. Make up your own metric code problem.

From: Activities Handbook for Teaching the Metric System



To answer the following problems choose the best estimate from the three choices given. Then connect the letter of each problem with the answer for that problem.

a. The length of a dollar bill
(A) 15.7 cm (B) 14.6 mm (C) 13.9 m

b. The weight of a math textbook
(A) 3.5 mg (B) .8 kg (C) 52 g

c. The volume of the gasoline tank in an automobile
(A) 20 cm^3 (B) 15 ml (C) 80 l

d. The area of the surface of a classroom floor
(A) 800 cm^2 (B) 600 m^2 (C) 70 m^2

e. The temperature of boiling water
(A) 98.6°C (B) 100°C (C) 212°C

f. The distance from Los Angeles to New York City
(A) 5250 km (B) 1000 km (C) 9550 m

g. The volume of a can of punch
(A) 2.5 ml (B) 1.5 l (C) 30 cm^3

h. The weight of a paper clip
(A) 1 g (B) 1.5 mg (C) 10 mg

i. The diameter of a dime
(A) 18 mm (B) .18 cm (C) 1.8 m

j. The volume of a teaspoon
(A) .05 m^3 (B) 5 ml (C) .5 l

k. The weight of an elephant
(A) 10 t (B) 10,000 g (C) 1 kg

l. The height of a man
(A) .010 km (B) 6 m (C) 180 cm

m. The weight of a man
(A) 75 kg (B) 325 kg (C) 175 kg

n. Normal body temperature
(A) 100°C (B) 37°C (C) 56.5°C

o. The weight of a shot-put
(A) 16 kg (B) 7.26 kg (C) 454 g

p. The volume of a carton of ice cream
(A) 2 l (B) 100 ml (C) 130 m^3

q. The length of a swimming pool
(A) 100 m (B) 25 m (C) .5 km

r. The distance to the moon
(A) 385,000 km (B) 740,000 cm (C) 850,000 m

s. The volume of a classroom
(A) 390 cm^3 (B) 35 m^3 (C) 340 m^3

t. The length of a football field
(A) .9 km (B) 90 m (C) 900 cm

u. The weight of an automobile
(A) 2.2 t (B) 900 g (C) 100 kg

v. The volume of an eye dropper
(A) 500 ml (B) 6 cm^3 (C) 600 cm^3

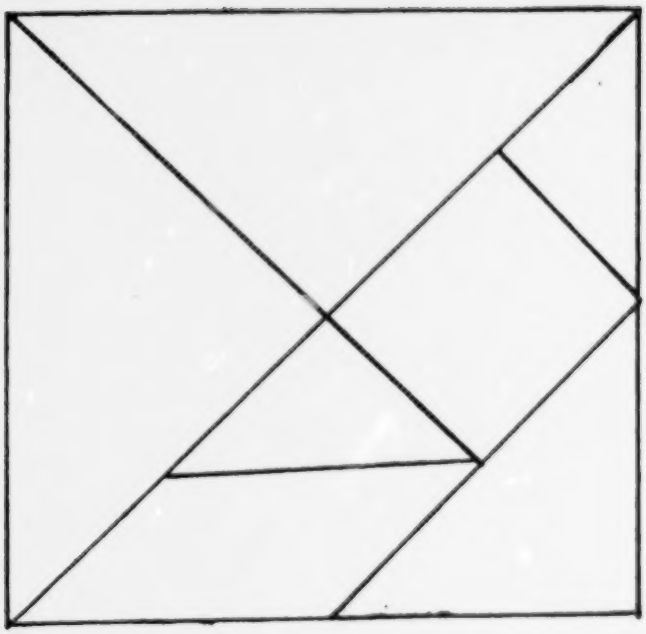
w. The diameter of a basketball
(A) 23 cm (B) 1.3 m (C) 33 mm

x. The perimeter of a baseball diamond
(A) 108 m (B) 250 cm (C) 1 km

From: Amusements in Developing Metric Skills

Appendix F

Tangram Puzzle



Cut This Out

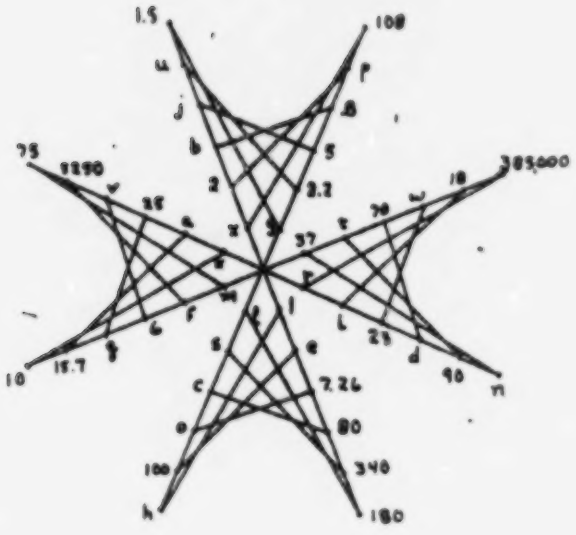
Appendix G

Key -- Pre/Post Test

Mastery Test Answers

1. meter
2. kilogram
3. liter
4. Celsius or Kelvin thermometer
5. cubic, cubic
6. square, square
7. 10
8. a. m
   b. km
   c. cm
   d. mm
   e. l
   f. g
   g. C
   h. cm^3
9. square meter
10. 5000
11. a. l
    b. kg
    c. m
    d. metric ton
    e. cm
    f. square meters
    g. degree Celsius
    h. kilowatt
12. 3 a.
    4 b.
    2 c.
    1 d.
    5 e.
13. 3 a.
    4 b.
    1 c.
    5 d.
    2 e.
14. a. 0.001 6, 160
    b. 0.004, 4
    c. 500, 0.000 5
    d. 0.26
    e. 22 400
    f. 10^6, 10^9
    g. 2200, 2 200 000
15. a. a little longer than a yard
    b. a little heavier than 2 pounds
    c. a little more than a quart
    d. a little less than 0.5 inch
16. 5, 5

Key - Mixed Measures



a.	A	15.7 cm	m.	A	75 kg
b.	B	.8 kg	n.	B	37°C
c.	C	80 l	o.	B	7.26 kg
d.	C	70 m^2	p.	A	2 l
e.	B	100°C	q.	B	25 m
f.	A	5250 km	r.	A	385,000 km
g.	B	1.5 l	s.	C	340 m^3
h.	A	1 g	t.	B	90 m
i.	A	18 mm	u.	A	2.2 t
j.	B	5 ml	v.	B	6 cm^3
k.	A	10 t	w.	A	23 cm
l.	C	180 cm	x.	A	108 m

35

Exploring Polygons

Marty Hearn

Exploring Polygons

Marty Hearn

INTRODUCTION

The purpose of this unit is to teach students how to identify polygons, apply their properties, and construct regular polygons. This is an important unit of study for several reasons:

1. Polygons are used frequently in the study of plane geometry and many theorems concern polygons which will be needed by those who continue their study in mathematics.
2. Polygons are used everywhere in architecture and industry. They are found in the construction of buildings, machinery, windows, jewelry, fabric design, floorcoverings, wallpapers, etc. Students need to investigate the role of polygons in these areas analyzing how they have and continue to influence their developments.
3. Polygons are found in nature adding both beauty and protection for many of natures creations. Student's need to develop an awareness of the many geometric shapes found in nature and the beauty they add.

This unit is designed to be used in the tenth grade gifted and talented geometry class and the work should be covered in approximately two to three weeks. This unit is excellent for the gifted because of the creative applications it provides. You will find that almost the entire unit centers around the students and their discoveries. The introduction of definitions and theorems are developed and applied differently than in the regular geometry class. In this unit, the students will be developing all the theorems through discovery using both inductive and deductive reasoning. They will be examining and applying the properties of polygons as they create original pictures and designs using polygons and tessellations.

Constructions of regular polygons using a protractor and straightedge have been included along with paper folding activities to create physical models of polygons. These activities are designed to motivate the students and strengthen their understanding of the concepts and ideas of transformation in geometry. The construction problems emphasize and promote complexities beyond the requirements of the regular curriculum which the gifted and talented need.

All in all this unit will enable the gifted student to experience mathematics intuitively and can be an exciting and fun unit for all involved!

OBJECTIVES

At the conclusion of this unit, the students will be able to:

1. Identify and name polygons and their parts.
2. Distinguish between convex and concave polygons.
3. Define and illustrate equilateral, equilangular, and regular polygons.

4. Prove and apply the theorem about the sum of the angle measures of a convex quadrilateral.
5. Develop and apply a formula for the sum of the angle measures of any convex polygon.
6. Identify the exterior angles of a polygon and apply a formula for the sum of the measures of the exterior angles of a polygon.
7. Determine angle measures and the number of sides of regular polygons.
8. Construct regular polygons.
9. Use both inductive and deductive reasoning to develop patterns and formulas for polygons and their properties.
10. Extend the properties of polygons to create original pictures and designs using polygons.
11. Critique geometric statements as to their validity and recognizing irrelevant facts.
12. Construct star polygons and create models of polygons through paper folding.
13. Combine their construction skills of regular polygons and knowledge of their properties to complete complex construction problems and abstract drawings and tessellations.
14. Research and investigate the influence of polygons in the development of many career areas.
15. Shape perception through activities involving the tangram puzzle.
16. Appreciate the role of geometry in life outside the classroom as reflected in nature, art, architecture and design.
17. Participate and interact in a team approach to problem-solving.
18. Solve and design problems using polygons to derive an answer.

INTRODUCTORY ACTIVITIES

1. Pretest for students to demonstrate their knowledge and usage of the properties of triangles. (Appendix A)
2. Pretest to determine students ability to perform basic constructions. (Appendix B)

Teacher Tip: These can be administered as two pretests or in-class worksheets. Students need to know this information before studying this unit. Prior to giving pre-tests, ask the students the following:

1. What is the compass used in construction for?
2. What is the straightedge used in construction for?
3. How does a straightedge differ from a ruler?

3. The names for polygons are easier to remember if you know the meaning of some Greek and Latin suffixes and prefixes. Have students use a dictionary to find the meaning of the following:

poly-	hexa-
quadri-	nona-
deca-	octa-
-gon	-lateral
sept-	tri-
hepta-	dodeca-

Students will use these in the developmental activity introducing polygons.

Teacher Tip: If a case bulletin board is available somewhere in your school, see if you can use it to show off some of your students best creative designs, constructions, and tessellations that will be produced from this unit of study. Also, consider doing a bulletin board in your classroom on polygons leaving areas where additional work done by the students can be displayed.

Teacher Tip: This unit is designed to be used with any standard Geometry text. Other assignments either in or out of class can be assigned from the text your class is using to reinforce the theorems developed in this unit and their usage.

DEVELOPMENTAL ACTIVITIES

1. A good approach to developing a definition of a polygon is to write the word polygon on the board and have the students try to determine what a polygon is or what it might look like based on their definitions for poly- and -gon. Then formally define and illustrate using their input where possible.

Teacher Tip: The easiest way to teach the polygon concept is to give plenty of examples rather than dwelling on a formal definition.

2. In developing a definition of convex and concave polygons, draw on the chalkboard illustrations of each and ask your students to explain in their own words the differences they can see between convex and concave polygons. Together work toward a more formal definition. Have students to diagram two concave regions whose union is convex.
   Now challenge students to do a formal proof proving that the intersection of two convex regions is a convex region.
3. In developing other definitions and names for polygons, define and illustrate the following related to polygons: diagonal, side and vertice (both consecutive and nonconsecutive).
   Put on the board the following chart:
   Based on their definitions for the suffixes and prefixes done earlier have students try to complete the chart on their own. Then go over together illustrating each type.

Number of sides	Name of Polygon
3	
4	
5	
.	
9	
10	
12	
n	

4. Brainstorm with students about these geometric shapes called polygons and where they seem to appear in our environment. Have students find different things in the classroom that reflect usages of these shapes. Have them give examples of polygons in architecture, design, sports, nature, etc. Discuss the influence geometry has had on the world outside the classroom.
5. Have students draw 5 quadrilaterals. Then for each, draw in the two diagonals. Have students consider this proposition: The diagonals of a quadrilateral always meet inside the quadrilateral.

Have students discuss whether this is true or false giving specific examples to support their position.

6. Have each student draw polygons with 4, 5, 6, 7, 8, 9, and 10 sides drawing all possible diagonals in each. Divide the class into small groups and challenge them to find a pattern to predict the number of diagonals, d, a polygon with n number of sides will have and then have them develop a formula.

Teacher Tip: A table might be helpful for them to gather the necessary information:

Number of sides	4	5	6	7	8	9	10	n
Number of diagonals								

7. Have the students criticize the following quadrilateral:

(Only has 3 right angles)

Ask students why such a figure cannot exist in Euclidean geometry. Explain.

Teacher Tip: If necessary, give the following hint to the students: Recall that a triangle has 180^0.

8. Again in small groups and using the same drawings as in Activity 3 and the information in Activity 7, challenge the students to find the formula for finding the sum of the measures of the angles of a convex polygon with n sides.

Teacher Tip: Again, a chart might be helpful for them. However at this point only suggest the chart after they have had ample time to try and discover it on their own.

Number of sides	Number of Triangles Formed	Angle Sum
4		
5		
6		
.		
n		

9. Using a straightedge, have each student draw a convex polygon. Then using a protractor have them measure each exterior angle and add all their measures together. Compare results and then present the formal proof on the exterior angle sum of a convex polygon to support their findings. Then have the students discuss the validity of the following statements:
Every pentagon is convex.
Every quadrilateral is convex.

Every triangle is convex.

Have students give specific examples to prove or disprove their validity.

10. Present the following:

    Extravagant advertising heard so frequently on television affords ample illustrations of the very common practice of using irrelevant facts to influence the listeners to buy special products. Irrelevant facts can also creep into geometry if you don't watch out.

    Now have the students read the following statement:

    If a polygon is a pentagon, the sum of its exterior angles, one at each vertex, equals 360^0.

    Ask students if they can criticize this statement. Discuss. Let the students decide how the statement should have been written.

11. Define and illustrate equilateral, equilangular, and regular polygons. Using these new definitions, have students try and determine the formulas for finding the measures of the interior and exterior angles of regular polygons.

12. Have the class discuss the following having students come to the board to draw pictures illustrating each:
    a. An angle of a regular polygon cannot be congruent to an exterior angle. True or false?
    b. For no value of n is equilateral n-gon equilangular. True or False?
    c. A regular polygon was defined to be a convex polygon. Are there any concave polygons which have all angles and all sides congruent? Sketch and investigate.

13. Give handout on constructing regular polygons of 3, 4, and 6 sides. (Appendix C) Illustrate constructions and then have the students construct the following:
    a. A regular octagon with sides congruent to a give segment
    b. A square with a diagonal congruent to a given segment
    c. A regular hexagon with an 11-cm perimeter
    d. A regular dodecagon with sides congruent to a given segment
    e. A regular 16-gon with sides congruent to a given segment.

14. Handout worksheet on construction of a regular pentagon. (Appendix D) Using this challenge students to construct a regular decagon.

15. Have students construct a five-pointed star. Then have them research the pentagram, it's symbolism and the pentagrams found in nature. (Appendix E) Have students investigate nature's pentagrams by having them do the following:
    a. Find the names of 5 flowers that have pentagram blossoms.
    b. Name a plant that has either 5 petals on 5 additional petals (two pentagrams) or 5 petals on 5 sepals.
    c. Name 3 ways in which nature displays designs in parts of the plant and animal kingdoms.

    Have students share and discuss their findings with their classmates.

16. Challenge students with the following constructions:
    a. Use a protractor and a ruler to draw an octagon with sides of 5 different lengths all of whose vertex angles measure 135^0.
    b. Construct an equilateral triangle given an altitude that is congruent to a segment PQ.

17. Describe what a tessellation or tiling is and provide students with a handout illustrating some tessellations. (Appendix F) Have students determine which regular polygons witl form a tessellation. Ask students to investigate why some shapes tessellate while others do not. Have students form small groups to discuss and try to come up with the explanation.
18. Using a small piece of cardboard, have students make a stencil of a letter of the alphabet that can be drawn as one polygon.
    Have students create a tessellation using this stencil. Let each share his drawing with the class.
19. Have students create an original tessellation using only squares and equilateral triangles. Encourage the use of colors to give it pizazz!*
20. Have students create two tessellations of their own. Assume one is to be a floor-covering or wallpaper, and the other a fabric design for a quilt. Encourage students to use different colors and to be creative!*

*Students are to show these finished products to the class. Classmates will evaluate their peer's designs on a basis of 1 to 10. Evaluation forms would be helpful:
For example: Evaluation

_____ Was it original? (4 points)
_____ Was it colorful? (2 points)
_____ Was it eye pleasing? (2 points)
_____ Was it neat? (2 points)

_____ Total Points

CULMINATING ACTIVITIES

1. Applications of polygons: Present the following problems and have students solve.
    a. Your basketball team is about to play it's biggest rival, Gorilla Prep. Just as the game is about to begin, each of your five starting players gives a good-luck handshake to the other four players on their team. Using a geometric figure, determine how many handshakes there will be.
    b. Each side of an octagon is 20 centimeters long. What would be the length of each side of a square having the same perimeter?
    c. Each of six persons talks to the other five by telephone. How many calls were made? Use a geometric figure to determine the solution.

    Have each student draw up two problems that would use geometric shapes to solve. Collect, reproduce, and distribute for the class to work. Then have

students evaluate the problems suggesting changes and improvements where necessary.

2. Carry nature in pentagrams one step further. Have students measure the distance from the tip of one petal to the tip of a nonadjacent petal and then divide that distance by the distance between two adjacent petal tips. (See illustration) Repeat this procedure for two or three more 5-petaled flowers. Have students look up and research the Golden Ratio and compare this ratio to their findings.

   The golden ratio is said to indicate proportions that are most pleasing to the eye. Have students compare a flower that does not have the Golden Ratio proportions to ones that do. Ask them which they found to be more eye appealing.
3. Bring in a panel of people from various career areas to discuss the use of polygons in their field of work. Architects, clothes designers, interior decorators, carpenters, brick masons, and artists are some examples.
4. Have students devise a method for creating star polygons using construction methods presented in this unit for pentagons. Any number of points may be used and they do not have to lie on a circle. Encourage them to use different colors for steps of different sizes.
5. Give handout on Escher tessellations. (Appendix G) Have students show off their creativity by creating their own pattern and tessellating with it.
6. Give handouts on Geodesic Domes. (Appendix H) Discuss the usage of polygons in this unique piece of architecture.
7. Have students cut out the polygonal shaped pieces of the tangram puzzle (Appendix I) and form the 13 possible convex polygons. For more fun, have them try to form any five from the designs on handout. (Appendix J)
8. Divide students into small groups and give handouts on polygons and paper folding. (Appendix K) Have students complete problems 39 thru 55.

   Teacher Tip: This is a lot of fun but students might need a lot of help getting started.

EVALUATION

1. Post-test: (40% of unit grade)
   a. Should test students knowledge of definitions and theorems pertaining to polygons and students ability to apply these properties to problem solving.
   b. Should cover both basic and creative applications of construction skills for regular polygons.
2. Daily grades: (20% of unit grade)
   a. Participation in discussions and demonstrations
   b. Daily work assignments (both in class and out of class)
   c. Developments in the development activities 2 and 17 and culminating activities 1, 2, 4, and 7.
3. Projects: (40% of unit grade)
   a. Development of the development activities 18, 19, and 20.
   b. Development of the escher tessellations - culminating activity 5.
   c. Development of the paper folding - culminating activity 8.

MATERIALS

Materials for Teacher: Appendix materials.
Materials Needed for Student Activities:

- Protractor
- Straightedge
- Ruler
- Compass
- Paper for constructions and paper folding
- Cardboard for stencils used in tessellating
- Colored pencils and/or pens
- Geometry text

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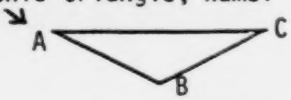
PRE-TEST: TRIANGLES AND THEIR PROPERTIES

I. For this triangle, name:



a. It's sides _____

b. It's vertices _____

II. 1. _____ is an acute triangle.

2. _____ is an obtuse triangle.

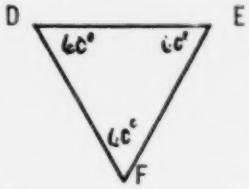
3. _____ is an equiangular triangle.

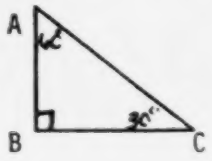
4. _____ is a right triangle.

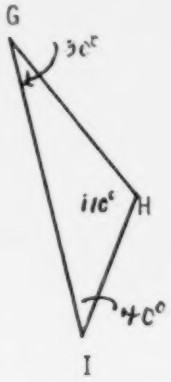
5. _____ is a scalene triangle.

6. _____ is an equilateral triangle.

7. _____ is an isosceles triangle.







III. TRUE OR FALSE:

_____1. Each equilateral triangle is isosceles.

_____2. No scalene triangle is isosceles.

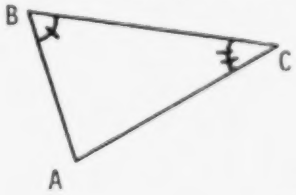
_____3. Some obtuse triangles are isosceles triangles.

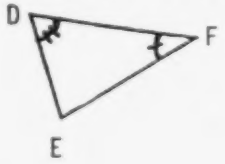
_____4. Some right triangles are obtuse.

_____5. If two angles of one triangle are equal to two angles of another triangle, then the third angles are equal.

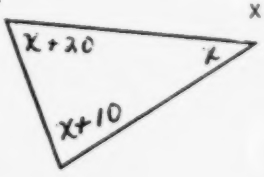
IV. Find the values for x and y in the diagrams below using all the given information:

1. Given: A = x + 80
E = 4x + 20
x = _____

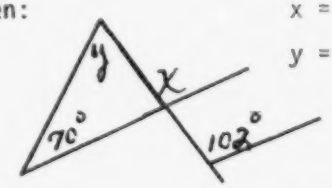




2. Given: x = _____



3. Given: x = _____
y = _____

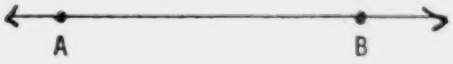


4. Given: x = _____

5. Given: x = _____
y = _____

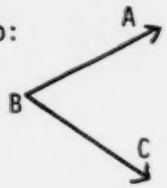
PRE-TEST: BASIC CONSTRUCTIONS

1. Construct a segment congruent to segment $\overline{AB}$.

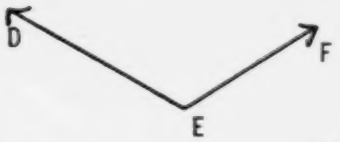


2. Construct an angle congruent to:

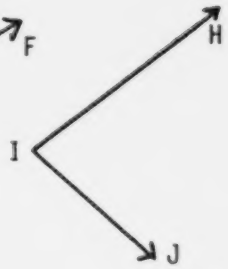
   a. $\angle ABC$



   b. $\angle DEF$

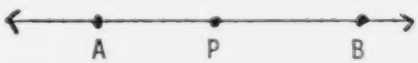


3. Bisect $\angle HIJ$



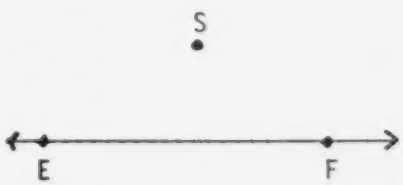
4. Bisect segment $\overline{CD}$

5. Construct a perpendicular to line $\overleftrightarrow{AB}$ through point P.



6. Construct a triangle with a 45° angle and sides congruent to segment $\overline{PQ}$ and $\overline{RS}$.

7. Construct a perpendicular to line $\overleftrightarrow{EF}$ through point S.

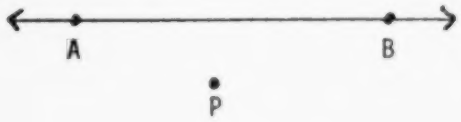


8. Draw three triangles--one acute, one obtuse, and one right. Construct the three altitudes of each triangle. What conclusions can you draw about the intersection of these altitudes.

9. Repeat #8, constructing the three medians.

10. Repeat #8, constructing the three angle bisectors.

11. Construct a line parallel to $\overleftrightarrow{AB}$ through point P.



(1.) **A regular polygon with three sides is an equilateral triangle. You can construct an equilateral triangle as shown below.**

Construction An equilateral triangle

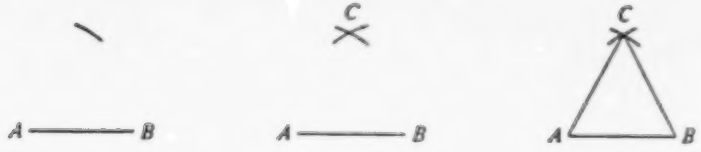
Given: $\overline{AB}$

Construct: An equilateral triangle with sides $\cong \overline{AB}$.

Open the compass to length AB. Draw an arc with center A.

Keep the same compass opening. Draw an arc with center B, intersecting the first arc at C.

Draw $\overline{AC}$ and $\overline{BC}$.

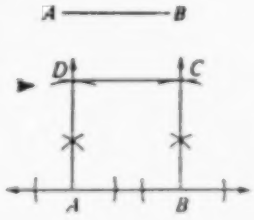


Conclusion: $\triangle ABC$ is equilateral.

(2.) **Using procedures similar to the above for constructing a regular hexagon, many other types of regular polygons can be constructed. Also, by bisecting angles of various measures, angles of other measures can be constructed. The example below shows two such constructions.**

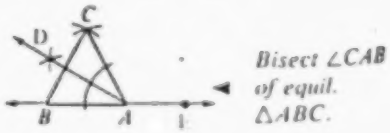
Construct each of the following.

A square with sides $\cong \overline{AB}$



Conclusion: $ABCD$ is a square.

A 150° angle



Conclusion: m $\angle DAE = 150$

CONSTRUCTING REGULAR POLYGONS WITH 3, 4, AND 6 SIDES

(3.) **A regular hexagon can be formed by joining six equilateral triangles as shown. This is the basis for the following construction.**

Construction A regular hexagon

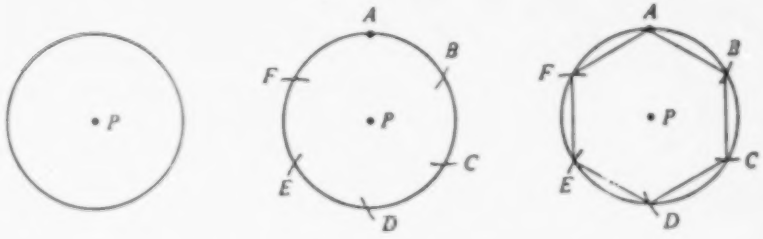
Given: $\overline{AB}$

Construct: A regular hexagon with sides $\cong \overline{AB}$

Open the compass to length AB. Draw a circle with center P.

Keep the same compass opening. Starting with any point A on the circle, draw a series of arcs on the circle.

Draw the segments.



Conclusion: $ABCDEF$ is a regular hexagon.

ENRICHMENT 5

Regular Pentagons and Decagons

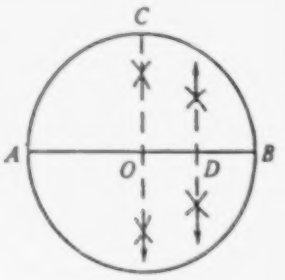
REGULAR PENTAGRAM

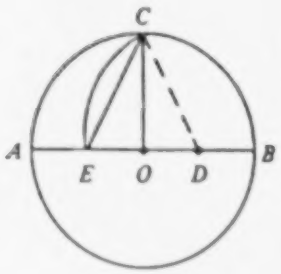
The pentagram was the symbol of the Pythagoreans, a society of mathematicians founded by Pythagoras, active during the sixth century B.C.

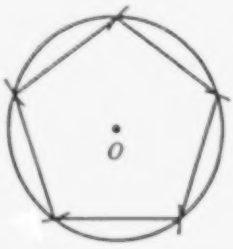
Construction: Regular Pentagon

Use only a compass and straightedge.

1. Draw diameter $\overline{AB}$ in circle O.
2. Construct the perpendicular bisector of $\overline{AB}$. ($\overline{CO} \perp \overline{AB}$)
3. Bisect $\overline{OB}$. ($\overline{OD} \cong \overline{DB}$)
4. With D as the center and $\overline{CD}$ as a radius, draw arc $\overset{\frown}{CE}$.
5. $\overline{CE}$ is a side of a regular pentagon inscribed in circle O.

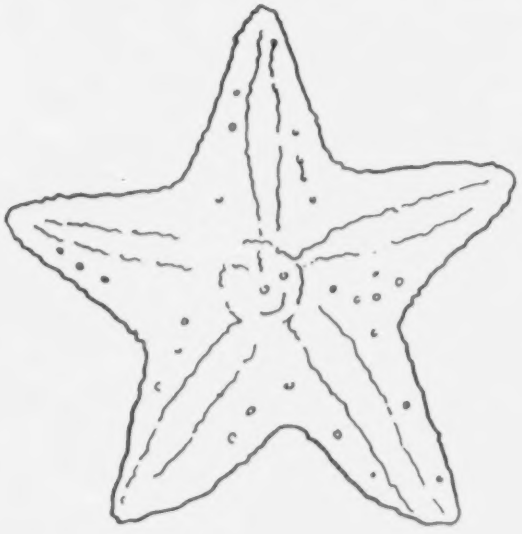




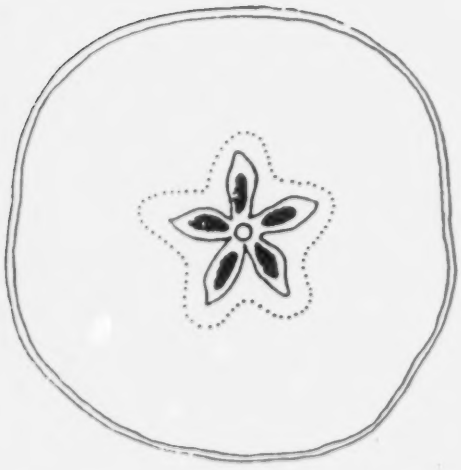


NATURE'S PENTAGRAMS

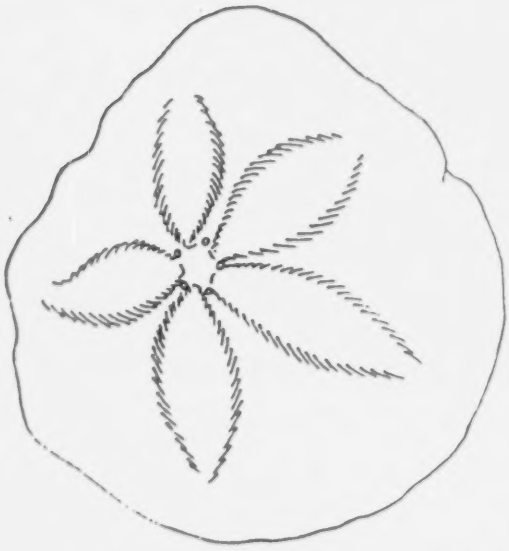
Hoya Blossoms



Starfish

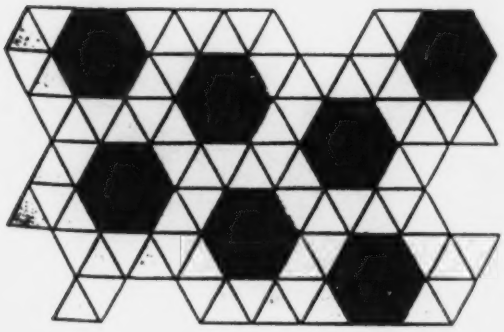


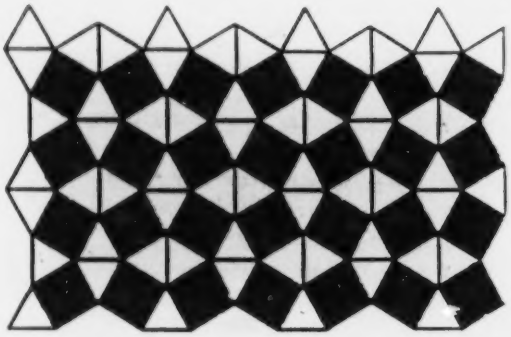
Cross Section of Apple Seedbed

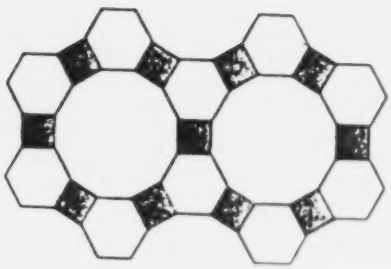


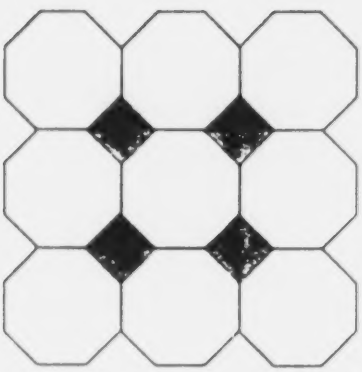
Sand Dollar

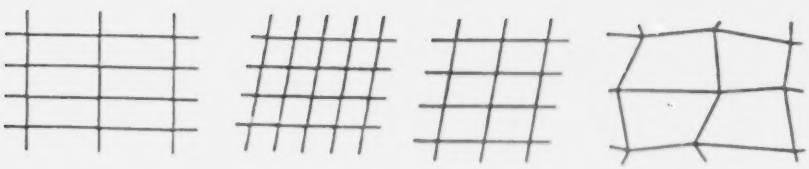
SAMPLE TESSELLATIONS

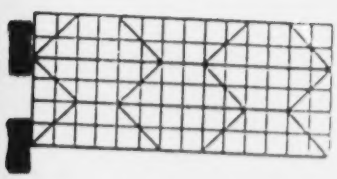


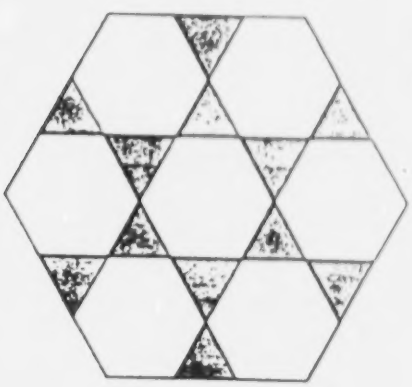


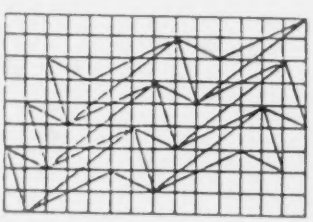




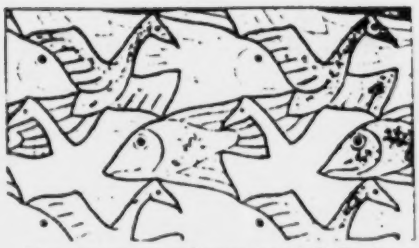








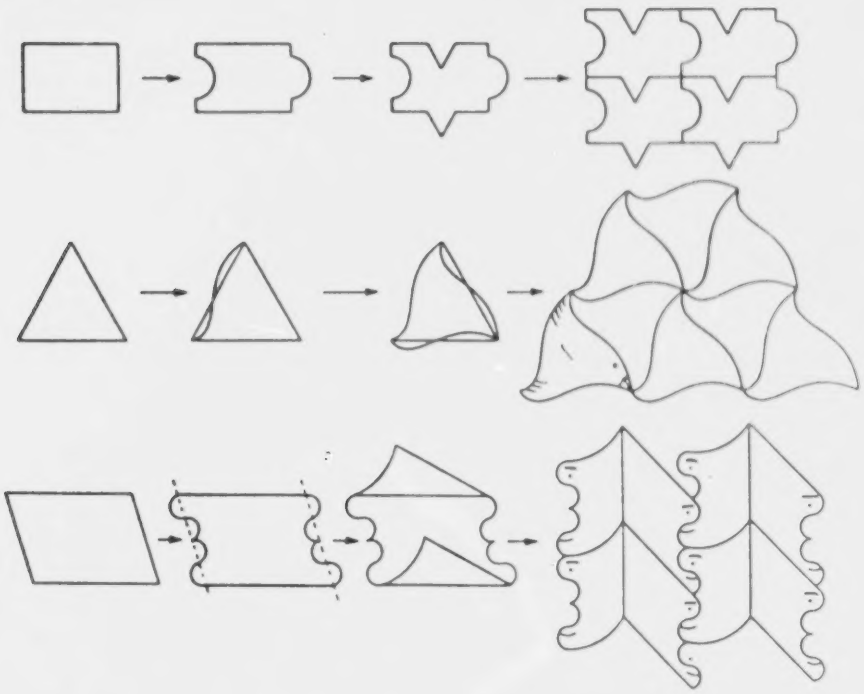
***Just for Fun*—Escher-type Tessellations**



Two Intersecting Planes, by M.C. Escher

This tessellation of birds and fish is a 1952 woodcut by M.C. Escher. Escher was fascinated by the fact that a surface can be filled up with figures without leaving any open space. As he once said, "This is the richest source of inspiration I have ever struck; nor has it yet dried up."

The following examples show a simplified step-by-step creation of figures for tessellating. By beginning with polygons which we know will tessellate, such as triangles, squares, rectangles, parallelograms, and so on, modifications can be made to produce a variety of shapes. These shapes may then suggest living figures which can be sketched as shown in the following examples. Create your own pattern and tessellate with it.*



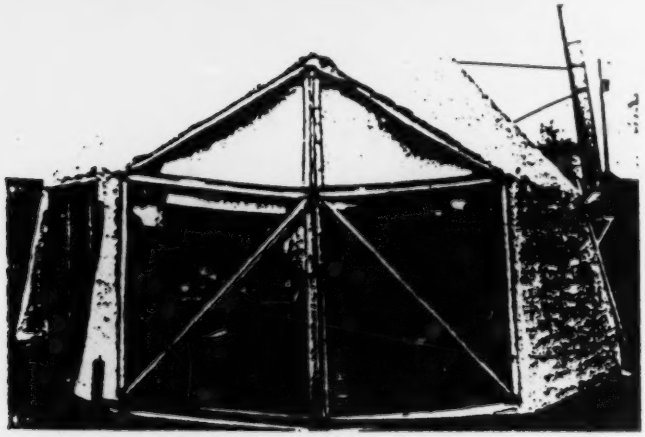
*See J. Teeters, "How To Draw Tessellations of the Escher Type," *The Mathematics Teacher*, 67 No. 4 (April 1974), pp. 307–10.

Geometry In Our World

Architecture: Geodesic Domes

The geodesic dome was introduced by R. Buckminster Fuller. His plans for one kind of dome, called a *sun dome,* can be found in the May 1966 issue of *Popular Science.*

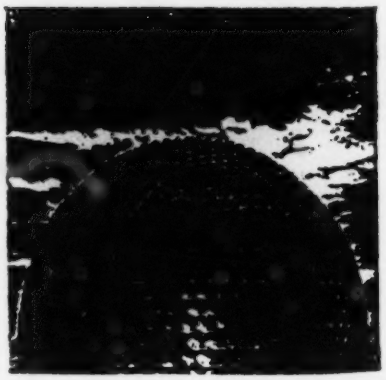
Domes of different sizes and shapes have been constructed from a variety of materials. Domes have been used as greenhouses, pool covers, and even houses. Shown below are a dome house in Colorado and a dome that can be set up at a campsite.



Geodesic domes are made as close to portions of spheres as is practical. Two reasons are that the sphere encloses the greatest volume with the least surface, and that it is the strongest shape.

Application

GEODESIC DOMES

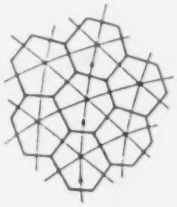


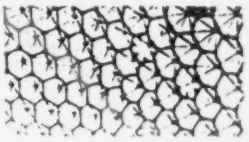
A spherical dome is an efficient way of enclosing space, since a sphere holds a greater volume than any other container with the same surface area. In 1947, R. Buckminster Fuller patented the *geodesic dome*, a framework made by joining straight pieces of steel or aluminum tubing in a network of triangles. A thin cover of aluminum or plastic is then attached to the tubing.

The segments forming the network are of various lengths, but the vertices are all equidistant from the center of the dome, so that they lie on a sphere. When we follow a chain of segments around the dome, we find that they approximate a circle on this sphere, often a great circle. It is this property that gives the dome design its name: A *geodesic* on any surface is a path of minimum length between two points on the surface, and on a sphere these shortest paths are arcs of great circles.

Though the geodesic dome is very light and has no internal supports, it is very strong, and standardized parts make construction of the dome relatively easy. Domes have been used with success for theaters, exhibition halls, sports arenas, and greenhouses.

The United States Pavilion that Fuller designed for Expo '67 in Montreal uses two domes linked together. The design of this structure is illustrated at the right. The red triangular network is the outer dome, the black hexagons form the inner dome, and the blue segments represent the trusses that tie the two domes together. The arrows mark one of the many chains of segments that form arcs of circles on the dome. You can see all of these features of the structure in the photograph at the right, which shows a view from inside the dome.





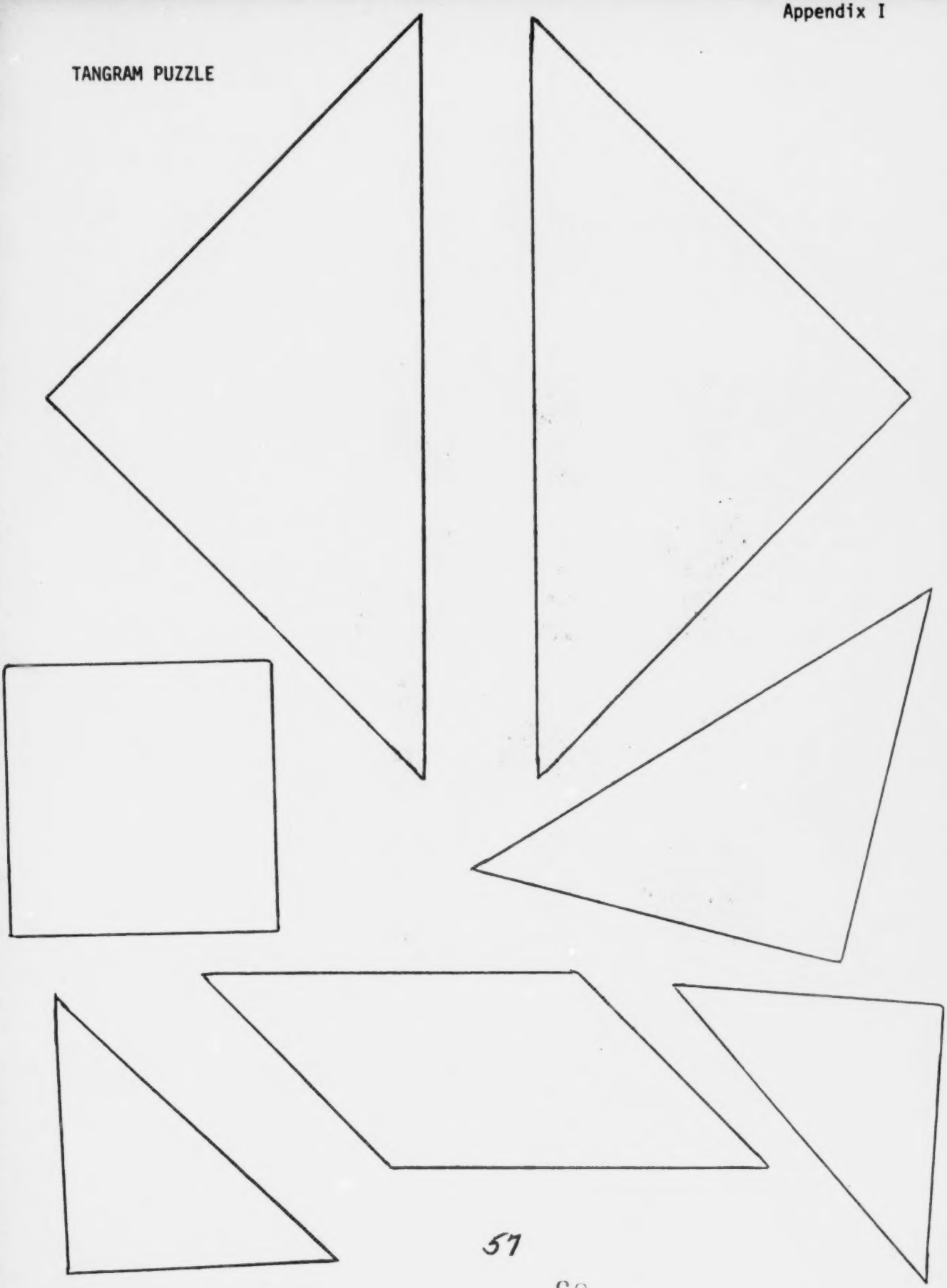
Exercises

1. In this exercise you will compare the volume of a sphere with the volume of a cube having about the same surface area as the sphere.
   a. Find the volume and surface area of a sphere of radius 7. (Use 3.14 for π.) $V \approx 1436.0$; $S.A. \approx 615.4$
   b. Find the volume and surface area of a cube with edge 10. $V \approx 1000$, $S.A. \approx 600$
   c. What is the approximate ratio of the sphere volume to the cube volume? ≈ 7.5

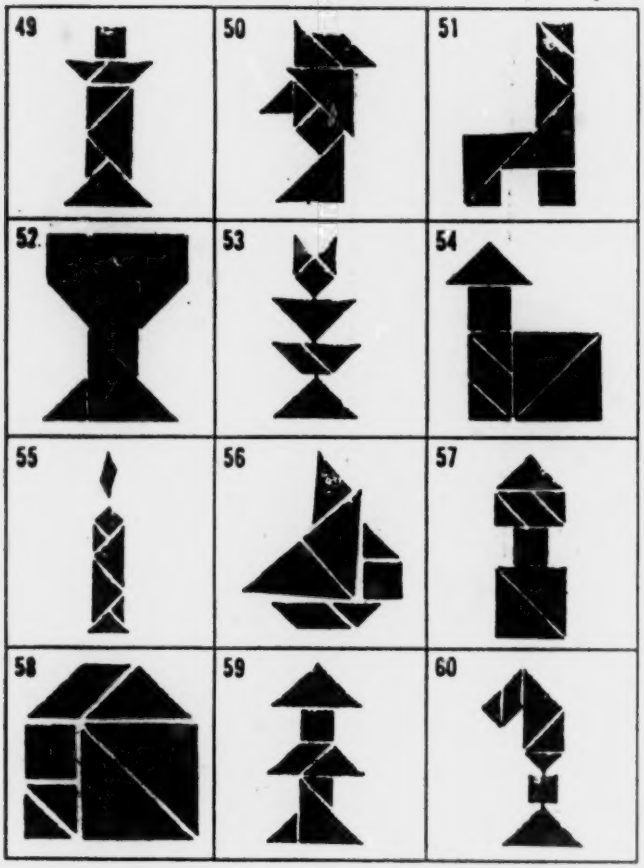
A cube has 8 vertices, 6 faces, and 12 edges. $8 + 6 - 12 = 2$. Leonard Euler (1707–1783) showed that for *any* solid with polygons for faces, vertices + faces − edges = 2. You can use Euler's formula to test possible frame patterns for a geodesic dome that completely encloses a volume. The pieces of tubing are the edges of the frame, and the points where they join are the vertices of the frame. Suppose you try to build a frame using n hexagons in the pattern shown in black in the diagram. Each hexagon contributes 6 vertices, 6 edges, and 1 face to the total, but 3 hexagon vertices combine at each vertex of the frame, and 2 hexagon edges combine at each edge of the frame.

2. The frame must have $6n + 3$ or $2n + 3$ vertices, $n + 2$ faces, and $3n + 3$ edges.
3. What is vertices + faces − edges for this frame? Does Euler's formula hold? Can the frame be built? 0, No, No
4. Show that if you change exactly 12 hexagons to pentagons, the frame will satisfy Euler's formula. (*Hint:* 12 hexagon vertices are lost, but since they combine in threes, the frame loses 4 vertices. How many edges does it lose?) 6
5. One of these pentagons appears in the photograph above. Can you find it?

TANGRAM PUZZLE



TANGRAM DESIGNS



Star and Polygon Construction

39. Triangle

Fold any three nonparallel creases that will intersect on the sheet (fig. 39).

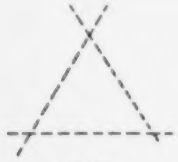


Fig. 39

40. Regular hexagon, equilateral triangle, and three-pointed star

Fold and crease a piece of paper. This crease is shown as AB in figure 40A. From some point O on AB, fold OB to position OB' so that angle $AOB' \cong$ angle $B'OE$. The congruent angles are most easily obtained by means of a protractor. They can also be approximated by judicious folding. Crease OB so that OA falls on OE (fig. 40B.). In figure 40B, XZ is perpendicular to OE, and the measures of OX and OW are equal. Cutting along XW results in a regular hexagon. An equilateral triangle results when a cut is made along XZ. Cutting along XY results in a three-pointed star.

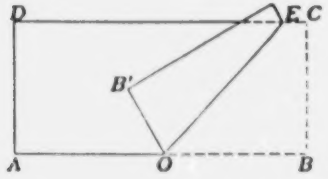


Fig. 40A

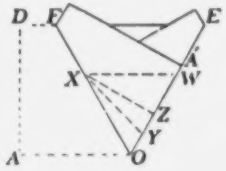


Fig. 40B

41. Equilateral triangle

a) Fold the median EF of rectangle $ABCD$ (fig. 41).

b) Fold vertex A onto EF so that the resulting crease, GB, passes through B. Denote by J the position of A on EF. Return to original position by unfolding. Fold line GJ, extending it to H.

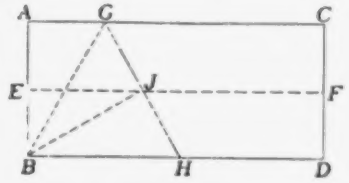


Fig. 41

c) By folding, show that BJ is perpendicular to GH.

d) What is the image of angle GBJ in a reflection in BJ? What is the image of angle ABG in a reflection in BG?

e) Fold the angle bisector of angle BGH and of angle GHB. What conclusions can be made after reflections in these angle bisectors?

f) Why is triangle BGH an equilateral triangle?

42. Isosceles triangle

Fold the perpendicular bisector of side AB of rectangle $ABCD$. From any point P on the perpendicular bisector, fold lines to vertices A and B. What conclusions can be made after a reflection in this perpendicular? (Fig. 42.)

Why is triangle ABP an isosceles triangle?

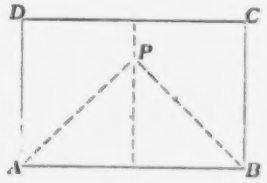


Fig. 42

43. Hexagon

Fold the three vertices of an equilateral triangle to its center (fig. 43). How is this center found?

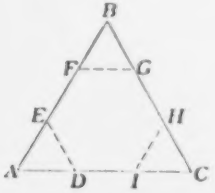


Fig. 43

Is the hexagon *DEFGHI* equilateral? How does the area of triangle *ABC* compare with that of hexagon *DEFGHI*?

44. Regular octagon, square, and four-pointed star

Fold a piece of paper in half and crease. Call the resulting line *AB*. Fold the perpendicular bisector of *AB*. Call this *OE*. (Fig. 44.) Fold *OA* and *OB* over so that they coincide with *OE* and crease *OF*. Mark point *W* so that triangle *OXW* is isosceles, and mark point *Z* so that *XZ* is perpendicular to *OF*. Cutting along *XW* will result in a regular octagon. A square results from a cut along *XZ*. Cutting along *XY* gives a four-pointed star.

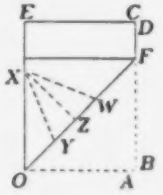


Fig. 44

45. Rectangle

Fold any straight line *AB*. At points *D* and *F* on *AB*, fold lines perpendicular to *AB*. At point *G* on line *CD*, fold a line perpendicular to *CD*. This perpendicular line intersects *EF* at *H*. (Fig. 45.) Show by folding that *GH* is perpendicular to *EF*. What is the image of *EF* in a reflection in *GH*?

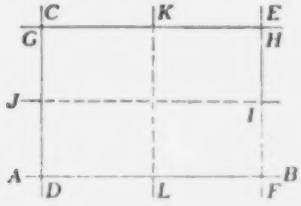


Fig. 45

Bisect side *EF* by folding. Fold a line perpendicular to *HF* through midpoint *I*. By reflecting rectangle *DFHG* in the line *JI*, what relationships among lines and angles appear to be true? Fold a line perpendicular to *GH* through midpoint *K*. Reflect the rectangle *DFHG* in *KL* and note what relationships appear to be true.

46. Square

Fold a rectangle so that one of the right angles is bisected (line *BE*). Fold *FE* perpendicular to *AD* (fig. 46). Why is *ABFE* a square? What is the image of *F* in a reflection in *BE*? What is the image of *C* in a reflection in *BD*?

Fig. 46

47. Other relationships in the square derived by reflections

Find the midpoints of the sides of *ABCD* by folding. Fold the diagonals *AC* and *BD*. Fold all possible lines determined by midpoints *E*, *F*, *G*, and *H*. (See fig. 47A. Also, see Appendix C for an enlarged model of figure 47A.)

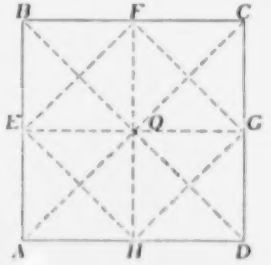


Fig. 47A

a) What are the images of *B*, *F*, and *C* in a reflection in *EG*? From this result, what line segments are congruent?

b) What is the image of angle *BOF* in a reflection in *EG*? Consequently, what angles are congruent?

c) What is the image of angle *FOC* in a reflection in *AC*? In *EG*? In *BD*? In *FH*?

d) What is the image of *C* in a reflection in *FG*?

e) What lines can be shown to be perpendicular by folding?

f) How does the area of inscribed square *EFGH* compare with the original square *ABCD*?

If the area of the original square $ABCD$ is 1 square foot, what are the areas of the other squares formed by folding the corners to the center? (Fig. 47B.)

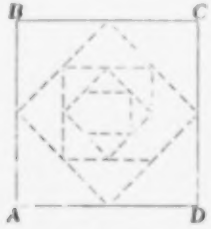


Fig. 47B

48. Octagon

Fold a square $ABCD$ to obtain the midpoints E, F, G, and H. Fold the inscribed square $EFGH$. By folding, bisect the angles formed by the sides of the original square and the sides of the inscribed square $EFGH$ (fig. 48). Fold the various diagonals AC, BD, EG, and FH. What are the images of HI, EI, EJ, and JF in a reflection in line FH? What are the images of the sides of octagon $EJFKGLHI$ in reflections in lines AC, BD, and EG? Why is $EJFKGLHI$ a regular octagon?

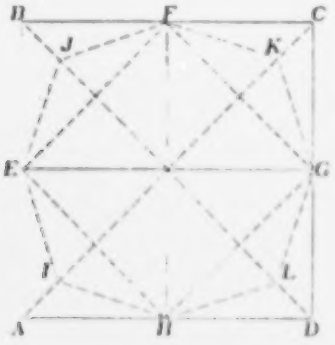


Fig. 48

49. Regular decagon, regular pentagon, and five-pointed star

Fold a piece of paper in half and crease. Call this line AB. If O is the midpoint of AB, fold and crease along line OE so that angle AOB equals one-half of angle BOE in measure (fig. 49A). This angle relationship can be assured by using a protractor or can be approximated by careful folding. Fold OE over so that it coincides with OB. Crease line OF (fig. 49B). Crease along OE so that OA falls along OF (fig. 49C). Triangle OXW is an isosceles triangle. Triangle OXZ is a right triangle. Cutting along XW results in a regular decagon. Cutting along XZ results in a regular pentagon. A five-pointed star is produced when a cut is made along XY.

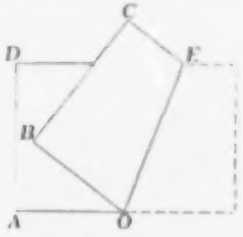


Fig. 49A

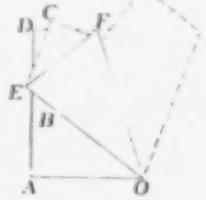


Fig. 49B

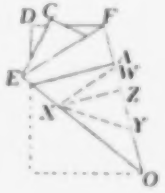


Fig. 49C

50. Six-pointed star, regular hexagon, and regular dodecagon

Fold a piece of paper in half. Call this line AB. Fold A over on B and crease along OE. Fold A and B over and crease along OF so that angle EOA equals angle AOF in measure (fig. 50A). This angle congruence can be assured by using a protractor or can be approximated by careful folding. Crease on OA, folding OF over to fall along OE (fig. 50B). Triangle OXW is isosceles. Triangle OXZ is a right triangle. Cutting along XW, XZ, and XY respectively will result in a regular dodecagon, regular hexagon, and a six-pointed star. Interesting snowflake patterns can be made by cutting notches in the six-pointed star design.

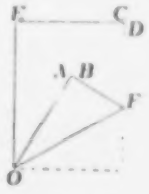


Fig. 50A

Fig. 50B

How Far? How Fat? How Full?
A Teaching Unit
on
Measurement

Danny W. Seaver

How Far? How Fat? How Full?
A Teaching Unit on Measurement

Danny W. Seaver

I. INTRODUCTION

The purpose of this unit is to provide the academically gifted middle school student (grades 6-7) with an understanding of the need for a standard system of measurement and to apply basic measurement to everyday situations. Expertise in measurement is necessary in today's highly technological society and the academically gifted student will be greatly involved in the technological advancements of tomorrow. Although this unit is designed for the academically gifted student, it can be easily adapted to use with all students or even used in a secondary level general mathematics class. The unit is concerned with linear, angular, and area measurements. Students use hand rulers, standard rulers, number lines, slide rules, protractors, and grid shapes to make these measurements. Triangles and Quadrilaterals are explored in terms of the measures of their sides and angles. This unit could be of great help in preparing students for geometry at the secondary level.

II. TEACHER TIPS

A. Have available as many measuring tools as possible. These should include: yardsticks, meter sticks, scales, and protractors. You may wish to collect such tools as graduated cylinders, barometers, thermometers, sextants, etc. to branch off into other related measurement activities and discussions.

B. Copies of some related activity suggestions may be found in the Appendix.

C. Gather as many materials as needed to construct rulers, grids, and slide rules to be used in certain activities.

D. Also gather many easily measured everyday items to be measured by students.

E. It is assumed that students have been introduced to basic measurement units and be experienced in basic computations with whole numbers and common fractions.

F. Audio-visual aids such as films, filmstrips, and transparencies are of great help and should also be gathered to use with this unit.

At the conclusion of this unit, the student will be able to:

A. measure objects using their own hand, span, foot, cubit, and pace.

B. convert hands, spans, feet, cubits, and paces to inches and feet.

C. measure lengths to the nearest half, fourth, eighth, and sixteenth of an inch.

D. identify pairs of equal fractions on number lines and rulers.

E. use a ruler to bisect a given line segment without measuring.

F. determine whether three given segments can be formed into a triangle.

G. draw and measure angles using a protractor.

H. construct an angle bisector using a ruler.

I. construct a triangle using a ruler and protractor.

J. apply ruler and protractor skills to create scale drawings.

K. determine missing angle measures of triangles and rectangles.

L. find the perimeter of any geometric figure having curved sides, straight sides, or both.

M. define area as a number of identical tiles to cover a surface.

N. determine areas of triangles and rectangles.

O. apply what they have learned about area and computation to solve practical problems.

P. improvise methods of measurement.

Q. demonstrate improved skills of observation and estimation.

IV. ACTIVITIES

A. Introductory

1. Have students measure various classroom objects, such as chalkboard, teacher's desk, and file cabinet, using the hand, foot, cubit, and pace; and make a chart to compare their measures with the other students.

2. Have students use an inch ruler to measure their body units; then

convert the classroom measurements made with those body units into inches and feet. Then allow students to compare again to see if their measures are now closer.

3. Have students mark their heights on the chalkboard and measure.

4. Give each student four squares and then ask them to cut each square into two equal parts with each square cut differently.

5. Demonstrate the use of such measuring devices as micrometers, vernier calipers, and thermometers. (Some of these items may be borrowed from the industrial arts department.)

6. Draw a long segment on a sheet of paper and ask students to figure ways of bisecting the segment.

7. Lead students to discover how an angle may be bisected through paper folding.

8. Have students observe the height of the classroom door, estimate the height, measure the height, and them compare the two heights.

B. Developmental

1. Give each student a measurement worksheet to be completed in his/her own time frame over the course of this unit.

2. Students will be expected to keep a notebook of all activities.

3. Guide students in constructing a slide rule. Then use the slide rule to add and subtract fractions with denominators of 2, 3, 4, 6, and 12.

4. Have students gather pictures of the use of triangles in construction and discuss the use of the triangle.

5. Have students research the historical development of standard measures and write reports and have presentations and discussions.

6. Have students interview businessmen or tradesmen who use measures. Discuss types of instruments used and the accuracy needed in certain situations. Contact surveyors, news copy editors, architects, engineers, etc. You may want to ask some to come into the class as speakers to demonstrate their measuring tools.

7. Teach students to use a protractor and have them measure various angles as well as draw certain angles.

8. Give students measures of angles and sides of triangles and have them draw triangles using those measures. Lead student to draw conclusions about relationships between sides and angles that lead to definitions of equilateral, isosceles, and scalene triangles.

9. Have students use the definitions from activity 8 to determine missing measures in triangles.

10. Have students measure the angles of many different triangles and discover that the sum of the angles of any triangle is 180 degrees.

11. Guide students in constructing rectangles using two strips of equal length attached in the middle. The strips represent the diagonals of the rectangle. After discovering that each angle is a right angle and that opposite sides have the same measure, a rectangle is defined.

12. Direct students through developing a scale drawing of the classroom.

13. Have students do scale drawings of rooms at their home or the lot, etc.

14. Have students use grids to figure areas of certain mathematical shapes.

15. Solve the problem of finding the perimeter of a curved figure through the use of string.

16. Find out how far each student in the class lives from school. Then have students prepare a chart or line graph to compare distances.

17. List those things in your school for which you would like more measurements. For example, the size of the principal's paddle, closest distance between opposite sexes allowed by school policy, length of lunch line, etc.

C. Culminating Activities

1. Have students cut out the tangram (see Appendix) and determine how the perimeter changes as they change the shape of the figure using all the pieces of the tangram.

2. Have students develop games which use measuring devices.

3. Have students compile a list of uses for body units that are still being employed, as for estimating room dimensions, placing the ball after a play in football, estimating fabric yardage, etc.

4. Students can use toothpicks or straws and glue to build bridges or other structures from a scale drawing plan.

5. Have students design an original measuring device and build if possible. Then discuss its various uses.

6. Have students research measurements used in astronomy and use those measures to compare to the basic units developed. For example, how many miles in a light year?

D. Differentiated Activities

1. Have students research and report some historical blunders through the inaccuracy of measurement.

2. Have students research and report some of the latest technological advancements in precision measurement. For example, those used by NASA.

3. Have students compare different measurement systems used in the different sciences. For example, those measures used in geology, astronomy, chemistry, physics, etc.

4. Have students list some things which cannot be measured. For example, the intensity of a kiss, human values, etc.

5. Have students research and report some discoveries and advancements made through the inaccuracy of measurements and mathematical errors.

V. EVALUATION

A. Students will be given pretests and posttests to evaluate the learning of the ideas of measurement.
B. Students will be given short check-up quizzes to see that they are mastering the activities.
C. The students' notebooks will be taken up and graded.
D. Teacher observation (how well students participated in activities and discussions).
E. Research reports evaluated by the students and teacher.
F. Self-evaluation: Ask each student to write a brief statement listing the basic concepts that he/she did not understand or failed to master. This should help the student to take a critical look at him/herself.

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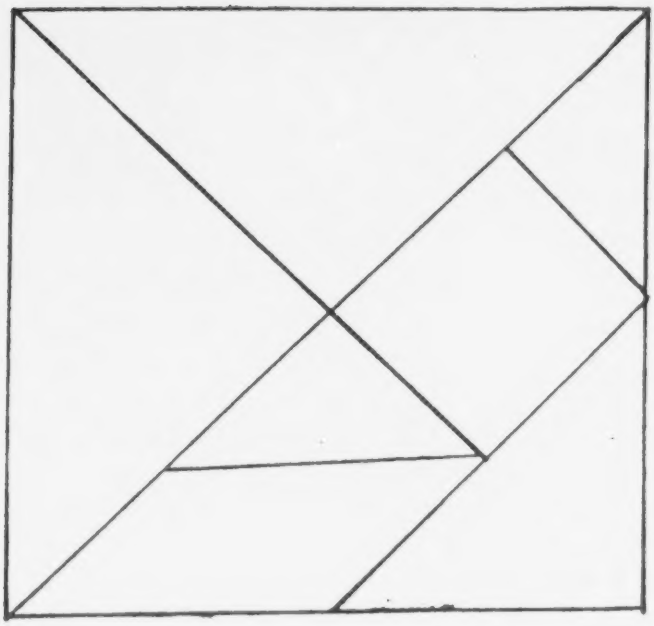
Appendix

Tangram Puzzle



Cut This Out

It All Depends on How You Slice It: A Study of Conic Sections

Sherry Austin

It All Depends on How You Slice It: A Study of Conic Sections

Sherry Austin

The purpose of this study is to enable students to identify each of the conic sections (circle, parabola, ellipse, and hyperbola), describe the characteristics of each conic section based on information obtained from their equations, graph each of the conic sections in the coordinate plane, and research how conic sections are used in areas such as architecture and communications.

This is an especially important topic for study by gifted students because conic sections are a required topic in Algebra II. However, the textbook usually provides little or no material on the history and applications of conic sections. This unit emphasizes research into the discovery and development of conic sections and the application of conic sections in areas such as architecture, communications, and astronomy.

This unit is designed for use with an Algebra II class. The activities may be used as each conic section is studied, or at the end of the conic sections chapter in the textbook, as extension and summarizing activities. Because of students' familiarity with the circle, this unit concentrates on the parabola, ellipse, and hyperbola.

Objectives

At the conclusion of this unit, students should be able to:

1. Identify the conic section described by a given equation;
2. Change the form of an equation for a conic section from general form to standard form, and vice versa;
3. Interpret the information given in the standard form of the equation of a given conic section (such as the location of the center, foci, directrix, vertices, major axis, minor axis, and asymptotes);
4. Graph each conic section using the information obtained from its equation;
5. Relate information from the textbook to problems from areas such as architecture, communications, and astronomy;
6. Compare and contrast the characteristics of the conic section;
7. Summarize the contributions of Menaechmus, Apollonius, Kepler, Galileo, and da Vinci to the study of conic sections;
8. Model an application of conic sections;
9. Create a line design or some other art work and/or write a short story using conic sections.

Introductory Activities

1. Work exercises in textbook.
2. Compile a notebook of all exercises from the textbook.

Developmental Activities

1. Take a 12" x 9" piece of waxed paper. Rule a line and mark a point not on the line. Fold this point onto the line at many different points. What conic section is formed? (parabola) The folds have what relationship to the conic? (They are tangents.)
2. Take a piece of paper and place a point 4 cm above the lower edge. Label the point F. Fold a corner of the paper so that the lower edge touches F. Open the paper and refold the corner so that a different point on the edge touches F. Repeat this folding procedure many times. Sketch in the curve formed by the creases in the paper. What curve is formed? (parabola) What is the focus? (F) Where is the directrix? (bottom edge of the paper) Place a point 10 cm above the lower edge of the paper. Repeat the folding activity. How does the shape of the parabola differ from the first parabola? What will happen to the shape of the parabola if F is 1/2 cm above the lower edge of the paper?
3. In 1594 Galileo conducted experiments at the Leaning Tower of Pisa and discovered the laws of falling objects. He discovered that the distance in feet (d) traveled by an object falling from rest in t seconds is found by using the formula $d\text{-}16t^2$. Find d when $te\{0, 1, 2, 3, 4, 5\}$. Plot the six ordered pairs, and connect them with a smooth curve. What curve would be formed if t were allowed to be negative as well as positive? (parabola)
4. The formula $y=5x^2 - 100x + 700$ approximates the curve of the cables of the Golden Gate Bridge. Find y for $xe\{0, 2, 4, 6, 8, ..., 20\}$.
5. A solar furnace can be constructed from an old army searchlight. Instead of reflecting light outward from a central bulb, the mirror will reflect the sun's rays inward to a focal point (focus). The temperature at the focus could be as high as 3500^0C. Focus comes from a Latin word which means "hearth" or "burning place." Explain why the parabolic shape of the mirrored surface enables the searchlight to be converted to a solar furnace. (Remember that the sun's rays are almost parallel when they reach the earth's surface.)
6. Take a 12" x 9" piece of waxed paper. Make a circle 4" in diameter. Take a point, other than the center, in the interior of the circle. Fold this point onto the circle at many different points. What conic section is formed? (ellipse) The folds have what relationship to the curve? (tangents)
7. Draw a circle of radius 8 cm. Locate and label a point P 5 cm from the center C. Fold a point on the circumference of the circle onto P. Repeat the folding procedure by folding at least 20 different point from around the circle onto P. Sketch in the curve formed. What is the other focus? (C) Pick a point on the ellipse. Find the sum of the distances from the point to the foci. Pick another point on the ellipse and repeat this procedure; compare the sums; are they the same? What happens to the shape of the ellipse as P moves closer to C?

8. Using rectangular graph paper, place tacks or pins at (-4, 0) and (4, 0). Label these point F_1 and F_2. Cut a piece of string and tie the ends together to form a 26-cm loop. Place the loop around the tacks. Keeping the string taut, draw an ellipse. What is the sum of the distances from the pencil to foci F_1 and F_2? What are the lengths of the major and minor axes? Move the foci to (-2, 0) and (2, 0). Use the same loop to draw an ellipse. What happens to the shape of the ellipse? What are the approximate lengths of the axes? Place both foci at (0, 0). Use the same loop of string to draw a curve. What curve is produced? (circle)
9. What happens to the eccentricity as the foci move toward the center of the ellipse? How is the shape of the ellipse affected? What happens to the eccentricity as the foci move toward the endpoints of the major axis? How is the shape of the ellipse affected?
10. The area of an ellipse is ab, where a is one-half the length of the major axis and b is one-half the length of the minor axis. If an ellipse is almost circular, the major and minor axes will be almost the same length. Explain how the formula for the area of a circle (r^2) is a special case of the formula for the area of an ellipse.
11. Investigate how the area of an ellipse compares with the area of a circle if the foci are the ends of a diameter. Will the areas ever be equal? If so, for what ellipses? (See activity 10 for area formulas.) What does the golden ratio [(1 + 5)/2] have to do with this problem? [If (a/b) = (1 + 5)/2, then area of circle=area of ellipse.]
12. Take a 12" x 9" piece of waxed paper. Draw a circle 4" in diameter. Choose a point outside the circle. Fold this point onto the circle at many different points. What conic section is formed? (hyperbola) What is the relationship of the folds to the curve? (tangents)
13. Using a rectangular coordinate system, label foci F_1 and F_2 at (-5, 0) and (5, 0) respectively. Label point P^1 at (6, 7). Loop a piece of string around a pencil at P and about F_1 and F_2. Hold both ends of the string below F_1 with the left hand. Hold the string against the pencil lead with the right forefinger. (The pencil should not slip along the string.) Pull both ends of the string with the left hand. The pencil should trace the upper half of one branch of a hyperbola. When the pencil gets to F_1F_2, hold the pencil against the lower string and continue. Measure the distances from P to each focus. What is the difference between the distances? What is the difference in the distances from any point on the hyperbola to each focus? Explain why this distance is constant as the string is pulled.

Culminating Activities

1. Research the contributions that the following made to the study of conic sections: Menaechmus, Apollonius, Johann Kepler, Galileo, Leonardo da Vinci. Write a 2-3 page report.

2. Research the discovery of and the development of the study of conic sections. Construct a time line, write a play, or choose another appropriate means to share what you learned.
3. Research and list applications for each of the conic sections (Appendix 1). Choose one application. Make a model or draw a diagram to explain how the particular conic section(s) has (have) been applied.
4. If you were a conic section, which one would you be? Why? What would your life be like?
5. Give each conic section a personality. Write a short story using these characters. (See example in Appendix 3.)
6. Using rectangular graph paper, form letters for the initials of your name using parabolas. Write an equation for each, stating the appropriate domain. (These can be posted for a bulletin board display.)
7. Line designs are geometric patterns formed by connecting points with line segments. The resulting design resembles a parabola. The shape of the parabola varies with the size of the angle. Create an original line design. Some materials that may be used are: nails and rubber bands, nails and yarn, and posterboard or cloth and thread.
8. Create a design, painting, etc. using only conic sections.
9. Create a computer program(s) to graph one or more of the conic sections.
10. Invite someone (such as an architect or communication or construction engineer) to speak to the class on how conic sections are used in his/her job.
11. Predict how conic sections will be used in 2050. Write a paper explaining these uses and/or draw diagrams.

Evaluation

1. Use teacher-made test(s) to ascertain the understanding of the concepts in the textbook.
2. Collect and grade the notebooks kept during the unit.
3. Read and evaluate the reports written at the end of the unit.
4. Have an English teacher read and evaluate the creative writing.
5. Submit creative writing/art to Creative Kids magazine.
6. Have an art show displaying the creative art. Art teachers may be invited to judge the works.
7. Let the computer teacher evaluate the computer programs. Also, other students may run the programs to test them.
8. Ask a physics teacher or another qualified person to evaluate the models.

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Applications of Conic Sections

Parabola

Searchlights
Automobile headlights
Cables hung between towers on a bridge
Radio telescopes
Radar antennas
Satellite dishes
Solar reflector in James Bond film The Man with the Golden Gun
Parabolic arches used to support concrete bridges from below
Design of buildings and roadways
Lenses for glasses, telescopes, microscopes
Mojave Desert--antenna-reflector system 64 m in diameter used to communicate with Voyager spacecraft at distances in excess of 950 million miles (Voyager has only a 20-watt transmitter)
Parabolic cylinder with a water pipe placed along its focal line was

constructed at Meadi, Egypt, in 1912; steam generated was used to operate an 100-horsepower engine

Ellipse

Elliptical-shaped pool table
Room with ellipsoidal ceiling gives whisper-chamber effect (examples are Taj Mahal and Statuary Hall in Capitol, Washington, D.C.)
Paths of comets (Halley's comet)
Orbits of planets around sun
Orbits of satellites around planets
Elliptical gears used where slow, powerful action is needed

Hyperbola

Design of McDonnell Planetarium, St. Louis
Shadow on wall from lamp
Paths of comets
Intersection of sonic boom shock wave with the ground

Our Vanishing Appalachian Environment

Katherine K. McGrady

Our Vanishing Appalachian Environment
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I. Introduction:

The Appalachian environment is rapidly changing. The purpose of this study is to preserve in the minds of the students an appreciation of the rich culture and the primitive environment of the Appalachian area before it disappears.

This unit in built around a one-day field trip to Linville Gorge, N.C. Many activities included in this unit will engage the students in the higher cognitive levels of thinking. Excitement and awareness of nature will be generated upon which understanding and appreciation of good conservation practices will develop. Students will be made more aware of their role in nature's preservation. This understanding and appreciation should make the students more productive members of society.

An interdisciplinary approach to learning will be used. Areas of study will include biology, history, language arts, art, and physical education.

This unit is designed to be used with a tenth grade gifted and talented biology class. The unit will be accomplished over a nine week period. Five weeks for introductory activities, one day for the field trip, and four weeks for follow up or culminating activities is suggested. The teacher could vary the amount of time spent on activities if necessary. For the most ideal plant study of spring wildflowers and the most favorable weather conditions the field trip to Linville Gorge should be scheduled between May 1 and May 10. To obtain permits to hike the gorge write National Forest Service, Marion, N.C., and provide the following information: name of persons in each group, date hiking into the gorge, and trails to be followed. The maximum size of hiking groups is ten persons; therefore, the class needs to be divided into small groups. At least one adult that is familiar with the gorge should accompany each group. An activity bus will be used for student transportation. One car will also be taken to be used in case of an emergency.

II. Objectives:

Affective Objectives:

At the completion of this unit the students will:

1. Realize a sense of fun and comradeship as a result of working together to accomplish activities. (A-2)*
2. Appreciate the rich culture and primitive environment of the Appalachian area. (A-3)
3. Show increased awareness of the importance of biological knowledge in everyday living and an understanding of how biology is related to many disciplines of their curriculum. (A-1)
4. Gain new insights into the personalities and talents of others involved in the study. (A-1)
5. Recognize their own ability to accomplish certain tasks or activities they have never tried before, as evidence by rappelling down a mountain, analyzing water samples, and preparing a video tape presentation. (A-4)

6. Consistently demonstrate their appreciation of good environmental conservation practices, as evidence by a log kept on personal conservation practices. (A-5)

*Coded according to Krathwohl's Taxonomy.

Cognitive Objectives:

At the completion of this unit the students will be able to:

1. Show knowledge of the history of the area of study. (C-1)*
2. Analyze reasons for changes that have occurred in the life styles of the Appalachian people in the past one hundred years. (C-4)
3. Show knowledge of crafts that are a part of Appalachian culture. (C-1)
4. Make judgements on the value of government controls on land use and conservation practices. (C-6)
5. Identify the major types of plants in the area of study. (C-1)
6. Show skills in rappelling and belaying. (C-1)
7. Compare the purity of water in mountain streams and rivers to the purity of water in the Piedmont region using chemical analysis and bacteriological techniques. (C-3)
8. Determine plant dominance in the area through collection of data and interpretation of charts. (C-2)
9. Analyze the reasons and suggest solutions for local environmental problems. (C-4)
10. Show development in communication skills by organizing the activities of this study into a video tape presentation. (C-5)

* Coded according to Bloom's Taxonomy.

III. Activities:

Activities are coded according to taxonomies and cognitive processes of Raths, Bloom, Krathwohl, and Guilford.

Introductory Activities:

These activities are to be accomplished prior to the Linville Gorge field trip. Emphasize physical fitness. Encourage students to begin walking a minimum of two miles per day to get ready for the field trip.

1. Ask students to observe people of the Appalachian area. To aid students in their observations, interviews with persons that have lived in the area at least fifty years might be used. (Observing, Comprehension)
2. Research history of the area. Students will be encouraged to do independent research using both school and public libraries. Students will be encouraged to read fiction book on the topic, and to use local historical society to obtain information. (Collecting and Organizing Data)
3. Following personal interviews and research, ask students to compare life styles of Appalachian people today with life styles 75-100 years ago. (Comparing, Synthesis)

4. Begin research on a prepared list of flora of the area. Flash cards and lab practicals will aid the students in learning the researched material. (Collecting and Organizing Data, Comprehension) See Appendix A.
5. Students will be asked to write for information concerning environmental protection laws and to obtain endangered species lists. Listed below are suggested people or places to write: Dept. of Interior, Washington, D.C.; National Wildlife Federation, 1412 16th St., N. W., Washington, D.C.; North Carolina Wildlife Resource Commission, Raleigh, N.C.; Dr. Jon Stuckey, Botany Dept., N.C. State University, Raleigh, N.C.; Dr. Al Radford, Botany Dept., UNC, Chapel Hill, N.C.; and Dr. I. W. Carpenter, Biology Dept., ASU, Boone, N.C.
6. Ask students to observe crafts that are a part of the Appalachian culture. Demonstration of crafts presented to students by Wilkes Cultural Arts Center. (Observing)
7. This activity will be used in connection with the study of Appalachian crafts. Students will be asked to bring in plant parts (leaves, roots, flowers, fruits) that they wish to use as natural dyes. Students will dye yarn to be used in a project or display of their own design. (Creativity)
8. After a review of Mary Jackson's book How Does Your Garden Grow? ask students to select a wildflower and draw, name, and caption their own creative design. (Creativity)
9. Ask students to keep a log of personal conservational practices. (Observing, Collecting and Organizing Data)
10. Observe land use in the Appalachian area. Discuss uses. A resource speaker will be used as a follow up to students observations. (Observing, Interpreting)
11. Observe evidences of misuse of land and other natural resources. Ask students to list and comment on the misuses. (Observing, Criticizing, Evaluation)
12. Ask students to draw and caption a cartoon that would emphasize environmental concerns. These cartoons would make a good bulletin board display. (Creativity)
13. Ask students to collect articles dealing with environmental problems using local newspapers. (Observing, Interpreting)
14. Show the film, "A Delicate Balance". This is a film made in Wilkes County showing conservation concerns. (Observing)
15. Learn to do a forest basal area count and interpret results. (Interpreting) See Appendix B.
16. Learn lab procedures for water purification tests. Water pollution kit available through Carolina Biological Supply will be used to make the chemical analysis. Environmental Engineers' Handbook by Liptak will be used to interpret data. Bacteriological analysis will be done using procedure listed in Microbiology by Pelezar. (Problem Solving, Application)

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17. Train students in the skills of rappelling and belaying. This activity has been used before very effectively. This activity stimulates excitement and makes students very aware and appreciative of their peer's cooperation. It also gives a real self confidence boost to students that do not usually excel in physical activities. Be sure gold line rope is used for this activity. It is suggested that an inverted Swiss seat be used for rappelling and that for safety reasons students be kept on belay at all times. (Application)

Activities accomplished during the field trip to Linville Gorge:

The field trip should be planned rain or shine. Rain will not effect the success of the trip. Rain will make Wiseman's View Trail very slippery. Students should use caution on this trail.

1. In connection with a one day field trip through a portion of Linville Gorge (10 hour trip) students will be divided into three small groups (Approx. 8 students per group). Each student will be responsible for one group activity during the field trip. Students should wear old clothes and sturdy shoes. (Leadership)
2. Each group will hike into the gorge from Wiseman's View and out of the gorge at Bable Towers. Students will be asked to observe and collect information. To aid students in this activity a scavenger hunt has been prepared by the teacher. (Observing, Collecting and Organizing Data) See Appendix C.
3. At Wiseman's View each group will participate in a mountain rappelling activity. This activity will take approximately 45 minutes per group. (Leadership, Cognitive Memory)
4. Each group will do a basal area lab. This lab will be done in different areas of the gorge so students will become aware of the effects of elevation changes on plant life. (Collecting and Organizing Data, Analysis)
5. Before reaching Bable Towers students will be stationed along the trail so they are not in sight of each other. They will be asked to write a short paper on "Nature Awareness". When students reach Bable Towers caution should be used because of crumbling rocks. (Observing, Summarizing)
6. Water samples will be collected for later lab use. Only one group will be responsible for this activity. (Collecting and Organizing Data)

Culminating Activities:

1. Following a study of plant identification and the study of major ecosystems, ask students to compare plant life in Appalachian area to plant life in other areas of North Carolina. (Comparing, Coding, Summarizing)
2. Following a study of chemical and bacterial contamination of water, ask students to compare purity of water in mountain streams and rivers to purity of water in lakes and rivers in the piedmont region. Ask students to determine or hypothesize

reasons for various types of pollution found in the water. (Comparing, Collecting and Organizing Data, Analysis)

3. Ask students to write a short paper that summarizes personal changes in environmental conservation practices and changes in attitudes that have occurred as a result of this unit. (Summarizing, Evaluation)
4. Using data collected from local newspapers on environmental problems, ask students to select one problem that they are particularly interested in and make a study of the problem. Students might write letterss to local newspapers, prepare a presentation for classmates to make others aware of the problem, or write letters to their congressman. (Collecting and Organizing Data, Evaluation)
* 5. Complete plant collection by plant families. Be sure students are aware of plants that are listed as endangered species and are aware of the laws protecting these plants. (Classifying)
* 6. Prepare a notebook which will include all work done in preparation for the field trip, the field trip itself, and all follow-up research. (Collecting and Organizing Data, Summarizing, Communication, Planning)
* 7. Students will prepare a video tape presentation to explain objectives and content of this unit of study to their parents. This activity does much to acquaint parents with the gifted and talented program and to improve parent-school relationships. (Creativity, Communication, Leadership, Decision Making, Planning, Collecting and Organizing Data)

* Various phases of these activities will be accomplished at different times throughout the entire unit of study.

IV. **Questions for discussion:**

Question coded according to Rath's taxonomy.

1. List misuses of land, sources of pollution, and bad conservation practices that you have become aware of during this study. (Summarizing)
   a) If these situations are not corrected how will this effect the Appalachian area 20 years from now? (Forecasting)
   b) What positive action will you take to help correct these situations? Give reasons for your decision of action to be taken. (Decision Making)
2. Compare a federally protected wilderness area to other wooded areas in the region that are not protected. (Comparing)
3. What are the effects of industrialization on various mountain crafts? (Hypothesizing)
4. Compare the life styles of Appalachian people today with life styles 75-100 years ago. (Comparing)
5. How is plant life in the Appalachian area different from plant life in other areas of North Carolina? How is it similar? (Comparing, Classifying, Summarizing)

6. How has our government aided in the conservation of natural resources? (Criticizing)
7. Discuss the different methods of forest management. (Comparing)
8. Discuss the role of sports people in a wildlife conservation program. (Looking for Assumptions)
9. Give evidence in support of the following statement: The same climatic regions are observed as one moves up a high mountain in this area as are observed as one moves from this area northward. (Interpreting, Summarizing)
10. Is the Appalachian area as we know it today a vanishing environment? (Summarizing)
11. Streams often are polluted by chemical-laden silt washing off farmlands or residential areas and the result is contamination similar to that from industrial or minicipal discharges. What is the taxpayer's responsibility for cleaning up this type of pollution? If chemical plants are required to clean up their wastes, should large corporate farms be exempt? (Summarizing, Criticizing)

V. Differentiated Activities:

1. In connection with a rappelling activity at Linville Gorge, two students in each group will be responsible for the belaying of their classmates.
2. During the field trip to Linville Gorge each group of students will be responsible for the collection of different types of data. This information will be shared with the rest of the class when they return to school.
3. In preparation of the video tape presentation to be viewed by parents, students will be involved in different activities such as writing scripts, filming, editing, directing and participating in various tape segments.

VI. Evaluation:

Students will receive daily grades on class activities. These grades will be based on student participation and accomplishment of tasks or activities, written assignments, oral responses and evidence of good laboratory skills.

Major grades will be given on work involving the video tape presentation, the notebook (project), and an essay and objective type test. The work done on the field trip will also be considered a major grade. The adult leader of each group will evaluate work done during the field trip.

The affective objectives of this unit will be evaluated by subjective evaluation of the teacher, student self-evaluation, by observing changes in self concepts, and by observing changes in behavior.

At the culmination of the unit each student will evaluate the accomplishment of the affective and cognitive objectives of this study.

VII. **Materials:**

Equipment:

Video tape equipment (Portable)
Television set
Gold line rope
Water ecology kit (Carolina Biological Supply)
High school ecology kit (Wilkes County Film Library)
This unit included filmstripes, records, books, transparencies, filmloops, and slide presentations.

Films:

Delicate Balance (Wilkes County Film Library)

Books:

The following books are available at Wilkes Central High School and have been found to be very helpful in the research of culture and history of the Appalachian area.

American Mountain People National Geographic Society
Appalachians by Maurice Brooks
Appalachian Dawn by John Foster West
Appalachian Ghosts by Nancy Roberts
Appalachian Trail by Ann Sutton
Carolina Crossroads by Rosser Taylor
Foxfire Book edited by Eliot Wigginton
Foxfire 2 edited by Eliot Wigginton
Foxfire 3 edited by Eliot Wigginton
Foxfire 4 edited by Eliot Wigginton
Great Smoky Mountains by Ruth Radlau
Great Smokies and the Blue Ridge by Peattie
Sourwood Tales by Billy Clark
Tales from Old Carolina by Frank Johnson
This Proud Land by John Foster West
Time Was by John Foster West
War Trails of the Blue Ridge by Shepherd Dugger
Where Time Stood Still by Bruce Roberts

The following books are available at Wilkes Central High School and have been found to be very helpful in the study of plant identification and ecology.

American Medicinal Plants by Charles Millspaugh
Ecology by Amos Turk
Environmental Engineers' Handbook by Bela G. Liptak
Field Guide to Edible Wild Plants by Lee Peterson

Flower Finder by May Watts
How Does Your Garden Grow? by Mary Jackson
Master Tree Finder by May Watts
Medicinal Plants and Their History by Edith Wheelwright
Microbiology by Michael J. Pelczar
What Flower Is That by Stirling Macoboy
Wild Flowers of North Carolina by William Justin
Wildflowers of the Southeastern United States by Wilbur Duncan

VIII. Appendices:

A. Linville Gorge Plant Study
B. Cover and Basal Area Lab
C. Linville Gorge Scavenger Hunt
D. Linville Gorge Wilderness Map (National Forest Service Marion, NC)

Appendix A
LINVILLE GORGE PLANT STUDY

Name of Plant

Common	Scientific	Identifying Characteristics	Uses	Seen in Lin. Gor.
magnolia	fraseri			
trailing arbutus	repens			
witch hazel	virginiana			
saxifrages	michauxii			
rue anemone (Windflower)	thalictroides			
wood anemone (Windflower)	lancifolia			
dogwood	florida			
partridgeberry	repens			
mountain laurel	latifolia			
blazing star (devil's bit)	luteam			
loosestrife	quadrifolia			
Jack-in-the-Pulpit	triphyllum			
lady slipper	acaule			
trillium (white)	undulatum			

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Name of Plant

Common	Scientific	Identifying Characterisitcs	Uses	Seen in Lin. Gor.
trillium (pink)	catesbaei			
trillium (Wake Robin)	erectum			
ground pine				
wild orchid (showy orchins)	spectabilis			
pipsisewas	maculata			
hemlock	caradensis			
wild iris	verna			
wood sorrel	violacea			
turkey beard	asphodelioider			
blue eyed grass	angustifolium			
mock strawberry	indica			
wild strawberry	virginiana			
bluet	caerulea			
dayflower	communis			
spiderwort	subaspera			
silver bell	carolina			
teaberry wintergreen	catawbierse			
rhodendron (Carolina)	maximum			
rhodendron (Catawa)	lucida			
rhodendron (rosebay)	strobus			
dog hobble (fetter-bush)	virginiana			

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Name of Plant

Common	Scientific	Identifying Characteristics	Uses	Seen in Lin. Gor.
pine (white)	eximia			
pine (virginia scrub)	capensis			
bleeding heart	borealis			
jewel weed	cordifolia			
Clinton's lily	canadensis			
foam flower	triacanthos			
golden seal	rubrum			
blood root	ovala			
locust	alba			
maple				
hickory				
oak				
cinnamon fern				
Christmas fern				
maiden hair fern				
liverwort				
mayapple	peltatum			
reindeer moss				
British soldiers				
foliose lichen				
galax	aphylla			
wild ginger	shuttleworthii			
Solomon's seal	biflorum			

Name of Plant

Common	Scientific	Identifying Characteristics	Uses	Seen in Lin. Gor.
false Solomon's seal	racemusa			
toothwort	laciniata			
chickweed	pubera			
bellworts	grandiflora			
cinquefoil	canadensis			
violet (dogtooth)	americanum			
violet (purple birdfoot)	pedata			
violet (white)	lanceckita			
violet (yellow)	hastata			
sassafras	albidum			
sumac	glabra			
rattlesnake plantain	pubescens			
indian cucumber root	virginiana			
yellow star grass	hirsuta			
hepatica (liverwort)	acatiloba			
mountain lettuce	micranthidifolia			
indian physic	trifoliata			
service berry	arborea			
virginia creeper	quinquefolia			
poison ivy	radicans			
sand myrtle	buxifolium			

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Appendix B
COVER AND BASAL AREA LAB

MATERIALS: Tape measure, meter stick, string and stakes.

PURPOSE: To become acquainted with a method of determining dominant species by basal area measurements.

DISCUSSION: Cover is the term generally used to indicate the area occupied by species, and is usually a measure of area covered by the crown or the stem of vegetation in the area. The crown is probably a better measure, but the stem is often more convient to measure.

PROCEDURE:

1. Measure off an area of the forest 100 meters by 2 meters. Mark with stakes and string.
2. Identify by genus and determine circumference of every plant in the marked area which has a circumference over 8 inches. Take circumference measurements at approximately 4.5 feet from the ground.
3. Record circumference data by genus.
4. Convert circumferences to basal area using Table I.
5. Complete data chart and summary questions.

Possible genus names you may need:
Abies (Hemlock), Acer (Maple), Carya (Hickory), Cornue (Dogwood), Magnolia, Pinus (Pine), Quercus (Oak), and Rhododendron.

BASAL AREA DATA CHART:

Genus Name (List alphabetical)	Total Basal Area			
	Group I	Group II	Group III	Total All Groups

Summary Questions:

1. What are the five most dominant genera in the area? (List in order of dominance.)
2. What type of forest association does your data indicate?
3. From research give a detailed account of the indicated forest association.

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Appendix C
LINVILLE GORGE SCAVENGER HUNT

For each thing asked for give the location where it was found and describe it and give the type.

I. Three types of lichens (2 pts. each)
   1.
   2.
   3.

II. An example of insect damage (2 pts.)
   1.

III. Three examples of areas where erosion has taken place (2 pts. each)
   1.
   2.
   3.

IV. Two examples of an animal home (2 pts. each)
   1.
   2.

V. An example of an animal track (2 pts.)
   1.

VI. An example of water purification (2 pts.)
   1.

VII. A parasitic plant (2 pts.)
   1.

VIII. Three examples of how man has abused the wilderness (2 pts. each)
   1.
   2.
   3.

IX. The effects of wind (2 pts.)
   1.

X. A dead animal (2 pts.)
   1.

XI. Four different evergreens (2 pts.)
   1.
   2.
   3.
   4.

XII. Two types of aquatic plants (2 pts. each)
   1.
   2.

XIII. Cushion Moss (2 pts.)
   1.

XIV. Babel Towers (2 pts.)
   1.

XV. Table Rock Mountain (2 pts.)
   1.

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XVI. Three examples of endangered species (2 pts. each)
1.
2.
3.

XVII. A pleasant odor (2 pts.)
1.

XVIII. A pleasing sound (2 pts.)
1.

XIX. Five non-evergreen trees (2 pts. each)
1.
2.
3.
4.
5.

XX. An example of xeric succession
1.

XXI. Three types of ferns (2 pts.)
1.
2.
3.

XXII. An example of the force of root growth (2 pts.)
1.

XXIII. Twenty wild flowers identified by name (1 pt. each)
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.

Extra credit: (1 pt. each)
List and give the location of other interesting, unusual or exciting things you noticed.

Adapting to Life

Malinda Jones

Adapting to Life
Malinda Jones

INTRODUCTION

The purpose of this unit is to help students gain a better understanding of adaptation and begin to identify and develop the necessary skills and values required for living in a changing world, e.g., creativity, flexibility, research skills. This is an important unit of study because of its universal nature. Living things frequently have to adapt in order to survive. More specifically, people continually find themselves in situations where they have to adapt physically, socially, and/or emotionally to circumstances that arise.

This unit is especially important for gifted students, since they will experience many changes in their lives. They represent the leaders of tomorrow and will make decisions that will affect themselves as well as humanity.

Although this unit is designed for a heterogeneous sixth grade class, it could be adapted to other grade levels. To provide for flexibility, more activities have been included than could be used during a four-week period. A special effort has been made to include activities, identified by an asterisk (*), especially suited for the gifted students. Also, the activities that are more specifically oriented to the scientific aspect of adaptation are identified by the letter "s".

OBJECTIVES

At the conclusion of this unit, students will be able to:

1) identify structural adaptations that enable animals to survive, e.g., coloration; differentiated limbs, appendages, beaks, etc.
2) create a model of an animal that could successfully adapt to their community.
3) develop a long range plan for their community.
4) assess their own values and create a "Personal Coat of Arms."
5) discover the influence of others' opinions on their own thinking.
6) develop coping techniques to adapt to new circumstances.
7) assess the problems associated with too much resistance to change versus "anything goes."
8) appreciate the courage and plight of people who, while searching for a better way of life, had to experience extreme change and adaptation in their life, e.g., early colonists, immigrants, etc.
9) forecast the occupations of the future.
10) forecast the family unit and its role on future generations.

INTRODUCTORY ACTIVITIES

1. Observe pictures of animals how their structural adaptations help them survive, e.g., snowy owl, lizards, snowshoe hare, etc. (S)
2. View the video, "Adaptation, Trial and Error", by the Phillips Petroleum Co. (See Resource Materials Section) (S)

*3. Minnows can change color to match their environment. To observe this attribute, fill two jars with water, and place some minnows in each jar. Place a light colored piece of paper of paper under one jar and a dark colored piece of paper under the other jar. Observe the color of the minnow after thirty minutes, and discuss the benefits of this adaptation. (S)

*4. Adaptation also refers to human behavior and values. To encourage the students to think about their own values and beliefs have them respond to the following questions:

1) Is there anything you would be willing to die for?
2) Is there anything you would not change about yourself?
3) Is there anything you would like to change about yourself?
4) If you could influence and convince people to believe one thing, what would it be?
5) Do you consider yourself to be openminded? Why or why not?

DEVELOPMENTAL ACTIVITIES

* 1. The bills, or beaks, of different birds are adapted to many different kinds of food. Collect pictures of birds in which the bills are easily seen. Speculate on the kind of food each bird eats. The diet of each bird can be checked in a field guide or a similar book. (S)

* 2. Dissect or observe the anatomy of a rabbit, squirrel, snake, and a bird. Compare and contrast the bone and muscle structures of these animals. Construct a chart summarizing your observations. Include on the chart the prey, predators, and habitat of these animals. (S)

3. Observe some pictures of animals, e.g., snowy owl, short horned lizard, chameleon, snowshoe hare, etc., describe how the color of these animals helps to conceal them from their prey, predators, etc. (S)

* 4. Observe a live earthworm. Notice the nature of the skin in particular. Compare the skin of the earthworm with that of a salamander. (S)

* 5. To demonstrate the structural adaptation that hair provides insulation to decrease heat loss do the activity, "How does hair help to keep an animal warm?" Conclude that hair is an adaptation that helps mammals keep warm. (S)

6. Observe pictures and if possible a live cactus. Identify the adaptations that help cactus survive in the desert. (S)

* 7. Observe the picture of one artist's idea of how the world's most successful adapted animal might appear. List the structural adaptations and how they would aid the animal to survive. Draw your own imaginary animal with its structural adaptations. (S)

* 8. Dinosaurs are extinct. Research this matter and infer why you think they became extinct. Summarize your inferences in a magazine article for National Geographic. (S)

* 9. The beaver's pelt, a structural adaptation, was a factor in the exploration and settlement of much of North America. Write a report on how the trappings of beavers, to obtain pelts, caused the number of beavers to decline and also led to the development of settlements. (S)

*10. Create a "What if. . ." composition: What if kanagroos were as large as the largest dinosaurs? What if birds did not have wings?, etc. (S)

*11. Create a story in which a cactus is transported to a place where the climate is cool and rainy. Describe how the cactus complains about conditions for which it is not adapted. (S)

*12. Create a model of an animal that would be able to live and hide on the school grounds. After the models are completed "hide" the animals on the school grounds and see which ones are found first and which ones are found last. Discuss why some of the animals are found more quickly than others. (Could also be used as a culminating activity.) (S)

*13. Have the students do the activity questionnaire, "What Do I Value In Life", to help clarify their own values.

*14. To help clarify your values do the following:

As quickly as you can, list 20 things you truly love to do. (No one else if going to see your list, so you can be completely honest.) After listing the 20 items, code them in the following way: (1) those that involve more than casual risk, (2) those that your parents would have been most pleased about, (3) those that best allow you to express your identity, and (4) those that will be least likely to remain on your list 10 years from now.

*15. Identify some ideas, beliefs, etc. that you are totally committed to, and other ideas you are more openminded about.

*16. Engage in the "Miracle Workers" activity . This activity will help students realize what they deem important in their lives, e.g., beauty, intellect, athletics, etc.

*17. To help students clarify their values, create a "personal coat of arms." This could also be used as a culminating activity.

*18. Read and illustrate the fable, "The Miller, His Son, and Their Donkey." Respond to the following:

a. To what extent are we affected by the clamor of public opinion?
b. When do you, or to what extent do you, trust your own judgment and common sense?
c. How do you feel when you take someone's advice and it turns out badly?
d. To whom do you seek advice from when you have a problem?
e. Tell about a time when you couldn't make up your mind. What did you do?

19. Assume the role of Dear Abby. Write a reply to a person who is having difficulty adjusting to a new school and neighborhood.

*20. Role play the following situations: Discuss the fears, anxieties, etc. of these situations. Conclude that people must adjust to these situations no matter how painful they may be. Discussing one's fears and/or seeking the support of a help group can also be beneficial.

1. birth of a baby in the family
2. death of a pet
3. death of a grandparent
4. death of a parent
5. death of a classmate
6. moving to a new school
7. parents getting a divorce

8. getting braces for your teeth
9. going to high school

*21. Observe some advertisements in magazines and on television. Identify and discuss which ads are more persuasive and why, e.g., emotional appeal, testimonial, band wagon, etc.

*22. Research the marketing strategy of "The New Coke" product. Why did the Coca Cola Company reinstate the "classic" coke product? Do you think this was simply a marketing strategy for "classic" coke from the beginning? Why?

*23. Several products, such as the Edsel car, seemed to be headed for success, but then they failed. Research some information on the Edsel car, etc. and infer why it was unsuccessful. What makes a product a success?

*24. It has been said that veterans returning from active duty in the armed forces have a difficult time "adjusting" when they return home. Interview a veteran for his/her opinion on this statement.

*25. Have students interview five different people and ask the question, "What was the biggest incident in your life that you had to adjust to?" As a class discuss, summarize, and categorize the responses according to family problems, physical problems, political issues, etc.

26. Assume the role of a handicapped person by blindfolding yourself, turning the television volume down, etc. Brainstorm a list of ways handicapped people have adapted to society.

*27. Research the lifestyle of the Amish people in Pennsylvania. In a report compare and contrast their way of life with yours. Why do you think they have been so reluctant to change? What can you learn from them and their resistance to change?

*28. The early colonists were indeed risk takers. They were courageous in their efforts to make a better way of life. They were, for the most part, working people, namely carpenters, farmers, fishermen, blacksmiths, masons, etc. They lived a rough life, very different from the security they had known in England. Yet, they were not bound by the old customs and traditions. They were free to try new things. Research the obstacles and difficulties the early colonists encountered and had to overcome in order to survive in America. What do you think motivated these people to take such a risk? Summarize your findings in an essay to be presented to the local historical society.

*29. Create a cartoon depicting mankind adapting to the "computer age."

*30. As technology and life styles change, some familiar occupations may become obsolete. When you become older, you may consider a career that does not even exist today. Think into the future and forecast a list of future occupations, and explain why they will be needed.

*31. To determine possible reasons why immigrants come to the U.S. listen to the song, "They're Coming To America" by Neil Diamond. What motivates these people to change their lifestyle and come to a foreign country. What adaptations will they have to make in this country. (Discussion Question #7).

32. To help determine the traditions and values of the family, do the following: After discussion with your family, compile a list of family traditions that are always observed, "written in stone." Now compile a second list of

family traditions or activities that have become somewhat altered over the years. Discuss the reasons and importance of these lists to your family now and in the future.

*33. Listen to several songs that were popular during the Vietnam War. What were the feelings being expressed in these songs? Were people right in expressing their opposition to the U.S. involvement in the Vietnam Conflict? Why didn't the "younger" generation accept the values of the "older" generation?

*34. Observe if possible, or if not have a guest speaker from a highly mechanized office talk to your class about the pros and cons of innovative machinery. How have computers, etc. affected the employees? Predict what the office of the future will resemble.

*35. Write an essay using the following:

Yesterday I was. . . Today I am. . . Tomorrow I will be. . .

This activity should help students set goals for themselves, as well as identify some of their values.

*36. The family unit has undergone some major changes in the past 20 years. More mothers are working outside the home, more fathers and mothers are in positions where they have to travel a great deal more, more children are being reared in single parent homes, etc. After reflecting on your own family and the trends you have observed, predict what the future family will be like. Do you think boarding schools will become more popular since most parents are involved with their work? Do you foresee grandparents playing more of an important role in the rearing of their grandchildren, etc.? Conduct a survey in your neighborhood about the future of the family unit and its roles. Report your findings back to the class.

*37. Research the whale's characteristics. It is possibly the most completely modified of all mammals for its physiology and anatomy have been completely changed to adapt to an aquatic existence. Summarize the information in a report, including illustrations, etc. (S)

*38. Study the handout, "Values and The Future" (Appendix G). Discuss the predictions presented by Baier and Rescher. Do you agree with their predictions? Why? Should their predictions prove to be true, what will be some probable consequences?

*39. Pretend you are an early colonist. Write an imaginary entry in a diary that the person may have kept.

*40. Have students compile the name, date, place of birth, occupation, and general biographical information for their grandparents and great -grandparents and beyond if possible. Encourage the students to focus attention on historical events such as wars, the Great Depression, farm droughts, migrations, etc., so they can see how their own families have been affected by such things. They may begin to see how their lives are a result of decisions made by parents and grandparents.

* CULMINATING ACTIVITIES

1. Create a model of what you believe would be the most adaptable animal that could survive on the Earth. (S)
2. Create a "Personal Coat of Arms".
3. After researching past events and observing present ideas and thoughts, submit a long range plan for your County and submit it to the County Board of Commissioners.
4. Write a letter to government officials concerning the issue of immigrants coming into the United States. Address the legal problems involved in obtaining citizenship, the time factor, personal hardships encountered, etc. Propose some alternative solutions for the problems faced by these people.
5. Submit a letter to the local college, high school, etc. detailing your predictions of the occupations in the future. Determine whether the skills needed for the occupations are being taught; if they are not being taught develop a program to be implemented.
6. Project your own future by setting some goals for yourself. Identify the means to achieving these goals, the time frame, etc. Also, identify some potential problems that could prevent you from achieving these goals as you have planned. How could you adapt to these potential problems?

(These culminating activities could also be used to evaluate the students.)

*DISCUSSION QUESTIONS

1. If we could never change our minds, how would this affect our lives?
2. If we all looked and acted exactly the same, what problems would it create?
3. Is it important to have people of all ages live in a community? Why?
4. If you did not have to attend school, how would you spend your time?
5. If you were suddenly sent to an unknown destination, what three things would you want to take with you?
6. What rule or law would you like to have changed at home, school, state, and nation? Why?
7. Many legal and illegal immigrants come to the United States searching for a better way of life. Some people are arrested and others die in their attempts to come here. What actions should the United States take concerning the continued influx of immigrants?
8. How has the "Computer Age" affected our way of life? Predict its impact on the future.
9. Society adapted to the Arab Oil Embargo by manufacturing smaller and more energy efficient cars, utilizing solar energy, carpooling, etc. Predict a crisis our society may have to contend with in the future; write an essay on how society will adapt to this crisis.
10. Discuss how the United States had to adapt to the Emancipation Proclamation, desegregation of schools, etc.

11. Select some quotes. Discuss your opinion of these sayings. Do you agree or disagree with these quotes? Why?
12. Discuss how the family unit has changed with the emergence of the "career woman".
13. What have been some of the major inventions, discoveries, etc. that have occurred over the past 50 years, and how has society adapted to them?
14. Discuss how eating habits have changed in the past 50 years.
15. Discuss the problems encountered when a family has to relocate to another area.
16. Discuss what impact television has had on society.
17. Discuss how advertisements can influence people's opinions and attitudes about products.
18. Today, in our society, there is an emphasis on youth and being young. However, growing old is a natural part of the human life cycle. Discuss how society has adapted to this way of thinking.
19. Discuss the projection of future trends. You can deal with any topic of interest cost of gasoline, candy, life expectancy, leisure-time activities, mobility rates, etc. Discuss what factors would influence your predictions.
20. Imagine that you could move back in history and change one incident. What would you change? Why did you choose that incident? Think of at least one positive and one negative consequence that could occur if you could make your change.
21. Is there any invention that you feel has harmed the world? Imagine if you could go back in history when the inventor was perfecting his invention. What would you say to convince the inventor that the world would be a better place if the invention never came into being?
22. Choose a discovery or invention you think has helped the world in some way. Discuss how the world might have been different if that invention or discovery had occurred at some earlier time or in some other place.

RESOURCE MATERIALS

Books:

Andrews, Roy Chaoman; Nature's Ways: How Nature Takes Care Of Its Own, Crown Publishers, NY, 1951.

Hobhouse, Henry; Seeds of Change, Harper and Row Publishers, NY 1985.

Milne, Lorus and Margery; Patterns of Survival, Prentice-Hall, Inc., Englewood Cliffs, NJ 1967.

Shippen, Katherine B.; The Great Heritage, The Viking Press, NY, 1947.

An Inventory of Historic Architecture, Iredell County, NC; Iredell Historic Properties Commission, 1978.

Iredell County Landmarks, Published by Iredell County American Revolution Bicentinal Commission, 1978.

The Heritage of Iredell County NC; Published by the Genealogical Society of Iredell County, 1980.

Magazines:
Ranger Rick
Nature Scope
Wildlife

Audio Visuals:
Slides "How Life Survives: Adaptation and Evolution" (Lenoir-Rhyne College)
"Galapagos Islands" (Dr. Marsha Fanning, Lenoir-Rhyne College)
Video "Adaptation, Trial and Error" (Lenoir-Rhyne College)
Filmstrips "Animals Struggle To Survive"
"See How They Swim"
"The Strands Grow"
(Filmstrips available through McGraw Hill Co.)

References:
Family Bibles
Genealogies
Newspapers
Iredell County Heritage Books
Songs, Records

Field Trips:
Catawba Science Center
Discovery Place, Charlotte, NC
Union Grove "Amish Community", Union Grove, NC

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Barlett's Familiar Quotations; Little, Brown and Co., Boston, 1968.

The Home Book of Quotations Classical and Modern, selected by Burton Stevenson, Dodd, Mead and Company, NY, 1935.

Silver Burdett Science, Silver Burdett Co., Sixth grade., Morristown, NJ, 1985. pp. 36, 39, 49-61.

BASAL TEXTS:
Celebrations (Reading Sixth Grade):
"Grandpa's Miracle" pp. 60-72
"The Boy Who Shaped Stone" pp. 81-94
"Digging for Clues to the Past" pp. 96-103
"Home From School" pp. 191-201
"Escape From NIMH" pp. 233-260
"Artic Fire" pp. 270-288

"On Little Cat Feet" pp. 292-307
"Conquering the Colorado" pp. 328-343
"Living at the Bottom of the World" pp. 346-358
"The Perfect Shot" pp. 484-503
"Lifeboat in Space" pp. 506-513

ACCENT ON SCIENCE (Sixth grade Science Book)
"Relationships Among Organisms" pp. 238-250
Health (Sixth grade Health Book)
"Values and Your Self Concept"

The Possibility of Probability and Statistics

Ione Collins

The Possibility of Probability and Statistics
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Introduction

"It is truth very certain that, when it is not in our power to determine what is true, we ought to follow what is most probable."
Rene Descartes

The fundamental concepts of probability underlie all of scientific theory. Probability and its technological brother, statistics, are used by most major industries in this country for maintaining quality control. Physicists develop new theories of atomic phenomena using probability as a fundamental tool. The meteorologist in forecasting weather, the agriculturist in predicting the size of next year's crop, the physician in making a prognosis about a patient's recovery, the psychologist in research design, the engineer in planning electrical systems, the astronomer in making statistical studies of galaxie distributions, the military strategist in planning defense and the medical researcher in assessing the effects of drugs and treatments to prevent or reduce the incidence of disease - each makes his professional pronouncements based on inferences drawn from the theory of probability.

Modern statistics is essentially a method for solving problems which involve making decisions in the face of uncertainties due to incomplete information. The special feature of statistical problem solving is the use of the theory of probability in choosing the method of sampling the data and in drawing conclusions about the population measures from the sampling statistics. In the theory of probability we deduce the probable composition of a sample from the composition of the original population and we reverse this reasoning - we infer the composition of the original population from the properly chosen sample. Thus, the scientist in almost every field designs his experiment, analyzes the data and interprets the results by the use of probability in statistical methods. The use of inferential statistics is basic to experimental research and a knowledge of statistics is fundamental to the intelligent reading of any research article.

Since gifted students, our future scientists, will need the probability and statistical concepts involved in the problems of thinking of a modern scientific and technological society, an early introduction, hopefully leading to a better understanding of these concepts, will help to provide a proper foundation.

The approach of this unit is an intuitive one and does not require a formal treatment of either probability or statistics. It does, however, attempt to allow the student to experience some of the important concepts and terminology. It provides for continued practice of the basic skill competencies dealing with computation of ratios, fractions, percentages, decimals and construction and use of charts and graphs in an interesting context. It gives an opportunity to develop and demonstrate the ability to experiment, to hypothesize, to predict, and to solve problems in the exciting context of probability. At the end of the unit the gifted

student will have a better understanding that mathematics is not a static subject and that it is indeed the universal language of the sciences.

The unit has been planned for use over a period of 5 to 6 weeks and can be extended to include set theory.

Tips for Teachers

1. Read the following before beginning the unit:
   "Probability" by David A. Page, pp. 229-271 and "Statistics" by Richard Pieters and John Kinsella, pp. 272-325 in 24th Year Book. The National Council of Teachers of Mathematics, 1959.

   "Teaching probability in intermediate grades" by Arthur Engel, pp. 87-150 in The Teaching of Probability & Statistics. Proceedings of the first CSMP International Conference. John Wiley & Sons.

2. Have a calculator handy to handle cumbersome addition, division, and multiplication to save class time.

3. Activities should be presented in sequence as given since some concepts used in later activities depend on those presented previously. Exceptions are numbers 15, 19 and 21.

4. Use paper cups or dice sups for tossing coins to prevent losing and wild tossing.

5. Additional computational exercises for homework and class assignments may be found in books listed in the bibliography. Be very careful to exclude any that require knowledge and use of combinations and permutations since charting large sample spaces may be fatiguing, e.g., 5!.

6. The use of the null hypothesis should be optional since some students may not be able to handle the logic of accepting or rejecting a null. If this is the case, use a simple alternate hypothesis for acceptance/rejection. Type I and type II errors would, of course, be modified also.

7. The unit can be modified to incorporate set theory notions in the explanation and demonstration of probability theory. Formulas may be presented using set notations if students have had prior introduction. It could be extended to include teaching set theory.

8. Structuring Algebra, listed in the bibliography, is especially good for combining set theory and probability.

Objectives

At the conclusion of this unit, the students will be able to:

1. Define and give examples of: sample space, mutually exclusive events, independent events, conditional events, a priori probability, a posteriori probability, hypothesis, random sample, biased sample, confidence level, control group, experimental group. (C-1) (C-2)*

2. Compute the probability of independent and mutually exclusive events (and/or) and conditional events (B given A). (C-3)

3. Make predictions based on probability tables. (C-3)

4. Construct charts and graphs and interpret information. (C-2)

5. Collect and organize data into frequency tables, line graphs and histograms. (C-5)

6. Evaluate ads, graphs and charts designed to mislead. (C-4) (C-6)

7. Design an experiment to solve a specific problem, carry it out and interpret results. (C-5)

8. Recognize the role of systematic planning in solving problems. (A-4)

9. Develop an appreciation for the importance of probability/statistics to the field of science and society. (A-3)

10. Develop an awareness that mathematics is not a static subject where everything is known. (A-1) (A-5)

* Coded according to Bloom and Krathwohl's Taxonomies.

Activities

A. Introductory:

1. Administer the pretest/posttest. (Appendix A)

2. Distribute 1 die and a number line numbered from -5 to +5 and a marker to be placed on zero to each student. Play individual games of moving right (even die numbers) and moving left (odd die numbers) by rolling the die 20 times with students keeping a tally of left/right moves. Compare individual results. Discuss the chance of winning (landing on +5) and the number of rolls required to win. Repeat 20 more times and again compare results.

3. Display 1 thumb tack for observation. Ask what is the chance/probability of it landing "point up"?; on its side?; what are we assuming? (it won't be lost or land point down.) Hypothesize how many times it will land on its side out of

10 trials; out of 100 trials. Have each student write his hypothesis on paper.

Distribute to each student a paper cup with 10 tacks. Have each toss 1 time on a smooth surface, record his data, and compare with his hypothesis. Accept or reject each hypothesis and point out the two types of errors made. Repeat the experiment 9 more times (student may change his hypothesis), a total of 100 tacks, and record the data. Compare with hypothesis and evaluate. Perform 10 more trials (100 tacks). Compare with results of the first 100. Are the estimated probabilities close? Are the results of the 2 trials of 100 close? What might account for the difference? Would you accept or reject your 2nd hypothesis? Suppose you tossed 1000 tacks, what would be the result? What can you conclude?

Point out and discuss:

a. This is an example of experimental probability. Ask for a definition in their own words.
b. If an event has a probability of 0, it will never happen (the tacks will land point down)
c. If an event has a probability of 1, it will certainly happen. (tacks will land point up or on the side)
d. If an event has a probability of 7/10, it will happen 7 out of 10 times: 7 out of 10 will land on their side; 3 will land point up. Thus 7/10 + 3/10 = 1
e. Probabilities can be expressed as ratios, fractions, decimals and percentages. Have student compute all of these.

4. Administer a 5-item true-false test written in French (Appendix C). Discuss the probability of making 100%, of missing all questions, of passing (getting 4 out of 5 correct). Have students state a hypothesis, then take the test. Keep tests and use as a culminating activity using the English translation.

Activities

B. Developmental

1. Display 1 coin. Discuss: number of possible outcomes; the probability of obtaining a head; a tail; assumptions. Point out that this is a priori probability. Discuss and determine an informal definition. Flip the coin several times to get a probability greater or less than 1/2. Discuss why it differs from the priori probability. Have students check this out with a visual interpretation of 10 tosses (Appendix D). Compare and discuss differences between each student's chart. Have students complete 100 tosses in class or at home and graph to show that in the long run the probability approaches 1/2 and state their conclusions. Make sure that they understand that even if 10 tails appear consecutively, the probability of the next event is still 1/2. (Appendix D)

2. Point out that each possible outcome is an event and that the set of all possible outcomes is an event space/sample space. List the sample space for 1 die and determine the probability of different numbers and the probability of not getting a number. Show P + not P = 1. Express probabilities as fractions, decimals and percentages. Have students chart and determine the sample space of: a. 3 coins; b. a pair of dice. (If some have difficulty designing a chart suggest a tree diagram.) Then determine: a. the probability of 1 head; 3 heads; 3 tails; 2 tails; b. the probability of rolling a sum of 4; 8; 6 etc. c. an informal definition of "event" and "sample space" in their own words.

   Homework: Solve the problem. An absent-minded 12 year old signed 3 valentines and addressed 3 envelopes. Then he/she put the valentines in the envelopes without paying attention to whom he/she wrote. Find the probability that: a. One or more valentines get to the right person; b. Exactly 1 valentine gets to the right person; c. Exactly 1 valentine gets to the wrong person.

3. Display jumbled "raw data" of the number of heads of 4 coins tossed 32 times. Determine how to make it more meaningful. Point out that this is what statistics is for. Tally the heads and summarize in a frequency distribution (Appendix E). Construct a histogram and convert to a line graph.

   Homework: Student determines a problem, collects and converts raw data to either a histogram or a line graph, writes 5 questions requiring interpretation of his data. Next day exchange papers and have students answer the questions posed according to graphs.

4. Compare experimental and a priori probability. A bag contains 10 marbles - 6 red, 3 black and 1 white. The marbles are mixed thoroughly and 1 marble is drawn at random, its color recorded and the marble is replaced 80 times. (Exhibit bag and marbles, demonstrate random selection and discuss definition of random.) The results are: Trials - 80; Number of red drawn - 44; Number of black drawn - 27; Number of white drawn - 9. Determine the probability of drawing: a. a red marble by chance; b. a black; c. a white. Convert to decimals. Discuss the type of example. Now determine a priori probability for each color from given example and convert to decimals. Compare and discuss. Have students write definitions of experimental and a priori probability and random selection in their own words. Hypothesize uses for each.

5. Present the Monte Carlo Method - a method of approximately solving mathematical and physical problems by simulation of random quantities. Accepted birthdate is 1949. Two American mathematicians Neyman and Ulman are the originators but the theoretical basis has been known a long time. In the Soviet Union, the first article was published in 1955. Its name comes from the city of Monte Carlo in Monaco, famous for gambling houses because one of the simpliest mechanical devices for obtaining random

numbers is the roulette wheel. The method does not help one win at roulette; it is not even an attempt to do so (Sobel, 1974).

Present: A simulation of random selection - "The Epidemic" Hermits 1, 2, 3, 4, 5 and 6 live on an otherwise deserted island. Today hermit 1 has an illness which can be passed on to anyone who is not immune. This illness lasts one day, and after that, the person is immune. Hermits 2 through 6 have never had the illness.

Roll a single die to determine which person the sick hermit visits today for help. (Ignore the sick hermit's number on the die.) The next day, the visited hermit will be ill and will visit someone for help. Roll the die again to determine who. Continue this process until a sick hermit visits an immune one and the illness dies out. Repeat this experiment 5 or 6 times, and find the average number who get the illness before it dies out. (Similar mathematical models are used to study actual epidemics.)
Using Advanced Algebra, 1978.

Compare individual student results and discuss who might use this model and how.

6. Point out that an Austrian monk, Gregor Mendel, founded the science of genetics in the 19th century with his experiments or cross-breeding. His discoveries, written in his report, "The Mathematics of Heredity," apply the theory of probability.

Present plant diagram (Appendix F.) If plants having red flowers are cross-bred with plants having white flowers, the seeds produced will grow plants having pink flowers. When pink plants are bred with pink, the new seeds produce 1 red, 1 white and 2 pink flowers (3rd generation). Let red = RR; pink = RW; white = WW and chart. Determine:

a. The probability of getting pink in the 2nd generation.
b. The probability of getting red or white in 2nd generation.

Then have students diagram cross-breeding of 2nd generation to produce the third generation and determine:

a. The probability of getting a plant with pink flowers.
b. The probability of getting a plant with red flowers.
c. The probability of getting a plant with white flowers.

Homework: Chart and solve: Several blue parakeets are mated with some yellow ones and every offspring is green. When the all-green generation is mated the colors are green, blue, yellow and white. Assume 2 pairs of genes determine color and if the genes of a parakeet include blue and yellow, it is green, and that white does not affect the color unless it appears with another color. Let Blue = BW-BW and Yellow = YW-YW. Make a table of the color of the 3rd generation of parakeets and determine the probability

of green, blue, yellow, and white. (Appendix G) You may wish to start a partial table in class. (Mathematics A Human Endeavor, 1970)

7. Present the probability of mutually exclusive events and have the class determine a definition and the operation for obtaining. Use a comparison of experimental and a priori probability to demonstrate. Have several bags of 10 marbles - 6 red, 3 black and 1 white. Determine the experimental probability of a random drawing of either a red or a black marble. Pair students to perform 10 or 20 trials and to collect data for 80 trials. On chalk board combine data from the pairs, e.g., Trials - 80; Number of red drawn - 44; Number of black - 27; Number of white - 9. Arrive at 44 + 27 = 71 and 71/80 = the probability of red or black. Then obtain a priori probability and convert both to decimals. Again discuss the reason for the difference. Have students write a definition of mutually exclusive events in their own words. Pose additional problems to solve, e.g., Determine the probability of drawing: a. a white or a red; b. a red or a black; c. a black or a red or a white. (Appendix H) Assign additional problems for homework.

8. Present determining the probability of independent events. Have class determine definition and try to develop an operation for obtaining. Use a comparison of experimental and a priori to demonstrate. Pair students to perform 20 trials and collect data for 80 trials. Use 1 coin and 1 die, obtaining, e.g., Number of times heads and a 6 resulted - 8; Number of times other combinations resulted - 72. Thus, 8/80 = 1/10. Determine definition by determining a property of a head and a 6 (neither depends on the other). By a priori obtain 1/2 and 1/6 and hypothesize operation. Check by trial and error. Pose additional problems. See Appendix I.

9. Present explanation of dependent events with a visual confirmation of operation used to obtain probability: A bowl contains 2 white balls and 1 black ball. If 2 balls are drawn in succession (the first not replaced), what is the probability that both will be white? Have students to chart the sample space listing the 2 drawn as W1, W2; W2, W1; W1, B; etc. and obtain confirmation that 2/6 = 1/3. Another simple example with an easy-to-chart sample space is the probability or correctly spelling a 3-letter word. Have students write a definition of dependent events in their own words. (This presentation could be extended to include the counting principle after which more difficult problems could be posed.). Compute additional dependent/conditional problems. (Appendix I)

10. Pose event statements and have students classify dependent vs independent. Include mutually exclusive events. (Appendix I)

11. Present the use of the terms "odds" and "complements". Refer to the previously used P + not P = 1. Give problems to compute using these terms (Appendix J).

12. Present the use of probability/statistics by insurance companies to determine the cost of premiums charged to the consumer. Show the 1958 mortality

table (Appendix K) - but not the death rate (or obtain a more current one, discuss and compare changes in probability). Pose questions:

a. Compute the death rate per 1000 at age 12, 25, etc.
b. What is the probability that a person who is 15 years old will die before age 40? What are we assuming? 12 years old?
c. Have students graph the data (may need help in determining the scale.) Note that the graph presents a general picture although specific facts can only be approximated.
d. Note that the mortality probability is an example of posteriori probability and discuss who might use/benefit from this type.

13. Present the concept of sampling as given in Appendix L. Discuss definition, uses for and relationship to probability theory and statistics.

14. Demonstrate a biased sample using an envelope containing 100 chips, 50 red and 50 white, unmixed with the red on top. Students collect sampling data and compare to results obtained in activity number 13. Discuss predictions made from biased samples and effects on decisions. Pose additional problems to solve, e.g.,

    Tom was practicing the most difficult multiplication facts. He got 10 out of 20 facts correct. Mary said Tom knew 1/2. Was she correct?

15. Introduce the misuse of statistics. Use an example of obtaining the mean (average) of weekly allowances of 5 children: $1, $2.50, $2, $1.50, $30. Would they all agree that they average $7.40 per week?

    The book <u>How to Lie with Statistics</u> can be used in any of the following ways:

    a. All students read chapter 5, 6 and 7.
        (1) Prepare an ad designed to mislead and present to the class for a group critique.
        (2) Construct a graph designed to mislead. Exchange graphs and have each write a critique and justify his reasons.
    b. Assign specific chapters to individual students to present a summary report to the class at appropriate times. Include charts, graphs, posters to illustrate points.
    c. As a text, reading assigned chapters relevent to daily introduced concepts.

16. Present the table of Language Arts and Math scores vs 6th grade achievement test/experimental test scores and question class relative to relationships (correlation) (Appendix M).

17. Present 3 rows of Pascal's triangle and question whether it reminds anyone of

    a previous activity. If not, distribute saved papers from activity number 2 (charting sample space of 3 coins) <u>OR</u> list on chalk board 3 rows as HT,

Verbal Problems
Beatrice A. Pickens

INTRODUCTION

The purpose of this unit is to apply computational skills of Algebra I to the reasoning skills in order to solve life-related mathematical problems. This is an important unit of study for two reasons: 1) this procedure enables students to transform math from the unreal world of the classroom to the real world of practical application and 2) this thought process can be expanded to evaluate current issues by defining the variables and their components.

This unit of study is designed for use in a ninth grade Algebra I G/T class. If used in an average ninth grade class, most of the current issue activities would be deleted. However, the home learning activities and the values activities that do not center around the class national issue ought to be included. The unit is designed for four weeks of study.

This is an appropriate unit for G/T because it expands the reasoning skills beyond the Algebra I level into the realm of critically assessing current local, state, and national issues. As possible future leaders, these G/T students need to be taught to critically evaluate issues before taking a stand. They also need to be encouraged to take that stand and be willing to support it based on analysis of the gathered data.

It is also an appropriate unit in that it introduces careers to these students that they may well have never been introduced to and might well find intriguing.

OBJECTIVES

At the conclusion of this unit the student will be able to:

1. Apply the five step reasoning process to interpreting verbal problems and current issues. This is the key objective and all the others are really objectives leading to the accomplishment of this one.

2. Identify the known and unknown quantities in a variety of verbal problems.

3. Define these unknown quantities in terms of one or more variables.

4. Translate verbal problems describing an unknown number into algebraic equations.

5. Translate verbal problems dealing with interest, chemistry, work, perimeter, area, etc. into algebraic equations.

6. Solve the equations to determine the unknown quantities required to meet the stated conditions.

7. Define the key parts (e.g. origin, pros, cons, leaders of, implications of, etc.) of the class current national issue.

8. Identify what questions must be answered to best understand the class issue and its implications.

9. Research the answers to these questions about the issue.

10. Form an opinion on the issue based on all the gathered data.

11. More deeply appreciate the role of mathematics in the real world.

12. Have an increased committment to studying local, state, national issues before forming an opinion on any issue.

13. Identify math-related careers and the level of mathematics needed by one in those careers.

TEACHING TIPS

In the teaching of this unit the teacher might want to keep in mind the following:

1. Instead of teaching verbal problems throughout the year, this unit is designed to bring all of the algebra together in this one practical application unit to be taught after teaching quadratic equations.

2. Bassler and Kolb offer the following questions a teacher ought to ask before beginning this unit:

   a. Can the student understand the physical situation which the problem portrays?
   b. Can the student translate from the language of the problem to the language of algebra?
   c. Does the student have sufficient understanding of the algebraic techniques necessary to solve the problems?
   d. Can the student interpret and check his solution to the physical problem? (Bassler and Kolb pg. 339)

3. Throughout the year, collect data on national issues from weekly periodicals.

4. Have the necessary containers and food coloring to conduct the experiment in developmental activity 2c.

5. Whether you use the problems in this unit or others, be certain to include problems with equations with one or two variables, radical equations, and second degree equations (both ones that can be solved by factoring and ones that must be solved using the quadratic equation).

6. Examples of each type of verbal problem should be discussed in class before asking the students to work problems. This should be done using the five step method and by investigation on the part of the students instead of the teacher telling the students how to do each one.

7. The developmental activities related to verbal problems should be done in the order listed while those related to other topics should be intersperced throughout the unit.

8. Because mathematics is basically a cognitive subject, teachers tend to neglect the affective domain. For this reason a separate section of activities on values has been included. These ARE NOT considered optional activities but should be used throughout the unit.

9. The home learning activities should be assigned early in the unit so that the data will be available when it is needed during the study.

10. It is strongly recommended that the teacher read the chapter indicated in Education and the Brain. This book can be found in the Lenoir-Rhyne College library.

ACTIVITIES

1. Introductory

a. Pre-test to test mastery in solving algebraic equations with one or two unknowns, equations with radicals, fractional equations, and quadratic equations. (Appendix A)

b. Discuss with the class the theories of brain-periodization and cognitive development in an attempt to help students understand why verbal problems have been so difficult in the past and to instill a degree of self-confidence in the student's present ability to solve them. (Appendix B)

c. Brainstorm the main national controversial issues of today. Decide as a class which one of these issues the class will analize. Admonish the student sot remain open on this issue and to, at no point in the study, reveal to their peers an opinion on the issue. This will be important at the conclusion of the study.

2. Developmental

a. Discuss the steps in problem solving. (Appendix C)

b. Follow the five step process to solve basic number problems. (Appendix D)

c. Conduct class experiment illustrating that adding a dilutant to a chemical increases only the amount of the dilutant. This can be done by diluting mixture of food color and water by adding more water. The desired conclusions are 1) amount of food color remained constant; 2) amount of water increased; 3) total volume = original mixture + dilutant. Repeat showing the opposite is true when pure food color is added. A third experiment begins with two mixtures of water and food color, one obviously stronger than the other. Pour part of the stronger into the weaker. The desired conclusions are: 1) amount of water has increased; 2) amount of food color has increased; 3) total volume = original volume

of weaker mixture + volume of more concentrated mixture; 4) total volume's concentration is between the two original mixtures.

d. Solve problems relating to chemistry, medicine, etc. where the volume of a chemical or medicine must be strengthened or weakened. (Appendix E)

e. Discuss the formula for interest. (I = prt)

f. Hypothesis with the class: "Our Nation without Credit Buying (Except Housing): What Would It Be Like?" Divide the class into groups and allow them to brainstorm this hypothesis. Discuss their findings. This should lead into value b.

g. Solve problems relating to interest earned on savings or spent on borrowed money. (Appendix F)

h. Discuss the formulas for perimeter and area of rectangles, area and circumference of circles. Perimeter of rectangle = 2(l + w), Area of rectangle = lw, Area of circle = πr^2, Circumference of circle = $2 \pi r$. Be certain students understand what each letter represents. Corralate perimeter and circumference. Show how each rectangular formula was derived.

i. Divide the class into four groups. Assigning each group one of the four formulas, ask them to write as many examples as possible of the real-world situations where it would be necessary to determine perimeter, circumference, or area.

j. Solve problems involving perimeter, circumference and area. Include some involving both area formulas as area of a track. Include some that total area and some area of borders around a given time. (Appendix G)

k. Given: Mary completes a task in three hours. Jane and Mary, working together complete the same task in two hours. Question for class discovery: What fractional part of the total task does Mary complete in the two hours they both work? (2/3) Translate this to the ratio (time working together):(time working alone) as the definition of any one member of a teams total contribution. Also, lead students to understand that the sum of all the ratios for all the members of the work force equals the one task to be completed.

l. Solve problems related to the job ratio. (Appendix H)

m. Ask the class to list the questions they would have to answer before they could determine which is the better alternative for them as a school principal in the following situation: School opens in one week. Both the student handbook twenty pages and the faculty handbook of twenty-three pages must be typed, run off and assembled before opening day. Seven hundred copies of the student and fifty copies of the faculty handbook are needed. Would it be cheaper for you to 1) ask your secretary to work overtime at time and a half pay or 2) hire a part time

secretary at minimum wage to help your secretary to complete the task?

n. Define the formula for distance: d = rt. Discuss examples of situations where it is necessary to compute times when two vehicles would meet as well as the effect of current on rate of travel for boats.

o. Solve problems related to distance. (Appendix I)

p. Brainstorm the class issue to determine what questions need to be answered to intelligently form an opinion.

q. Read from as many sources as possible about this issue collecting as much data as possible on both sides of the issue. Daily ask members of the class to share what they have discovered in their readings.

r. Based on the readings 1) define the variables in the issue, 2) define the implications of the issue, and 3) summarize the arguments for both sides of the issue.

s. Write two essays, one in favor of the issue and one against the issue.

3. Culminating

a. Solve a series of miscellaneous problems that depect realistic but unrelated situations. (Appendix J)

b. Ask each student to write on a sheet of paper whether he is for or against the class issue. Keeping this opinion secret, pair the students and have them exchange their two essays on the issue. After reading their partners essays, ask each student to determine how their partner stands on the issue. Questions for class discussion: Did your essays reflect honestly what they were supposed to? How difficult was it to write an essay on something you did not believe in? When might it be necessary to be able to do just that? Did your final opinion on the issue change after the study of the data?

4. Home Learning

a. Survey family and others in your neighborhood to find their opinions on the class issue. Determine not only what they think but why.

b. Discuss with parents all the items (including housing) that they are presently buying on credit and determine yearly interest they are paying. If possible, determine what percent of the annual family income is spent on paying for these items and what percent on interest.

c. Your family has decided that the interior of your home must be painted. Help your parents compute the total square footage of the surfaces to be painted. Using this information, the information on a can of paint about the numbers of square feet one gallon will cover, and the cost of one gallon of paint; to compute the

cost of painting the house.

d. With your family, plan a vacation that will take you to some place in the United States that is at least 500 miles from your home. Map out separate routes to and from this vacation place so as to see more of the country. Plan how far the family will travel each day, how many days will be spent at the chosen vacation place, and how many days will be required for the return trip. Based on the milage your family car gets and the price of gasoline, compute an approximate gasoline cost for the trip.

5. Values and Values

a. Report on home learning activity a. Discuss the reasons the students received from the point of soundness based on data verses the ones received on weakness based on prejudices. Write a letter to the editor entitled: "I am Tired of Letters Based on Feeling, not Facts"

b. After the class has completed developmental activity f, discuss as a class pro's and con's of credit card buying. Have the students to appraise the economic impact on an individual family if 1) the cards are wisely used and 2) the cards are excessively used.

c. Careers: Keep a running list throughout the study of this unit of the careers (blue and white collar) that use each of the different types of problems studied. Be certain to point out that all of these careers are open to males and females, blacks and whites. Ask students to choose differentiated activity b or c or create their own career oriented activity and complete it for class presentation.

d. "How much is a new car worth to you?" Ask the students to answer this question in light of all they have learned about credit buying. Their essays must include data on the dollar cost of the car, the sacrafices they will have to make to pay for the car, the weekly salary they will have to make in a part time job to pay for the car and keep it running, the impact this job will have on their life style. The final question they must answer is "Is the car worth what they will have to pay for it?"

e. Using the data in home activities c and d, pose the following problem for each student: You must cast a vote in your family on whether to paint or go on the vacation. The family cannot afford to do both. Before voting, the students are to go through the same process as in forming opinions on the class issue. Write out your vote and supporting reason. Once each student has reached a decision, divide the class into teams based on their votes and conduct a class debate giving each student the opportunity to share his share his reasons for voting as he did.

6. Differentiated

a. Select a second national issue. Follow the same procedure as with the class issue and write a pro and con essay.

b. Interview people in at least four of the careers listed in c under values asking them all the ways they use math on the job. Present this to the class in a unique manner (not in a dull oral or written report).

c. Explore one math-oriented career: 1) education required 2) career opportunities 3) salary levels, etc.

d. If the U.S. government were to maintain a balanced budget for the next five years, what long range effects on our economy will this have? Write an essay.

EVALUATION

1. Pre-Test (Appendix A)

2. Post-Test
   a. Paper-pencil test on verbal problems (Appendix K)
   b. Given the issue: "ERA: Should N.C. Support the Amendment?", what questions would have to be answered before forming an opinion on this issue?

3. Create your own problem. Prepare a flip chart showing step-by-step how you would solve this problem applying the skills of problem solving.

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APPENDIX A
PRE-TEST

I. Solve the following equations. (Holt page. 89, 172, 315, 379, 419, 443)

1. $3(x + 5) = x + 21$
2. $7(x + 1) - 1 = 2 - (5 + 2x)$
3. $2x^2 = -15x - 28$
4. $7x^2 + 15 = 2x$
5. $2x = 7y + 1$
   $5x + 3y = 23$
6. $2x + y = 3$
   $y = 2x + 1$
7. $\frac{3a - 4}{15} = \frac{2a}{5} + \frac{1}{3}$
8. $\sqrt{0.5x + 2} = 0.32x + 12$
9. $x2 + 11 = x + 1$

II. Translate the following verbal phrases into algebraic symbols. (Holt 71)

1. x more than y
2. m less than three times n
3. six times x, increased by five times y
4. seven more than twice a number, increased by 6
5. x more than eight times y, decreased by twice x

APPENDIX B
BRAIN-PERIODIZATION AND COGNITIVE DEVELOPMENT

The research of Dobbings and Sands (as reported by Epstein) indicates the following pattern in physical brain development:

> Analysis of the data into biennial increments shows that brain growth has two components. The first shows the increase in body weight. The second components appears in the form of spurts of five to ten percent in brain weight during the periods from two to four, six to eight, ten to twelve, and fourteen to sixteen years, the later two spurts being slightly earlier for girls and slightly later for boys.

The work of Piaget breaks the cognitive development into the following four stages:

1. Sensory-motor intelligence (0-2 years)
2. Preoperational representations (2-7 years)
3. Concrete operations (7-11 years)
4. Formal operations (11-15 years) (Wiiliams and Stith, p. 377)

The studies of Epstein in relating the two patterns have shown that the mental age for a child grows in spurts and that these spurts correlate with ages of physical growth. His work further indicates that children are unable to develop

new levels of cognitive ability when they are in a period of plateau between these spurts. For this reason, he contents that during plateau periods, students should not be introduced to new formal knowledge and this may well be the reason seventh and eighth grade students have such a difficult time with formal verbal problems as this is the time of one of the plateau periods. (Epstein, 1978)

Toepfer further indicates that in fact this is the lowest of the plateau periods when the child's mental age increases only seven months as opposed to twenty-eight to thirty in the previous and the following two year periods.

APPENDIX C
FIVE STEP REASONING PROCESS (Vannatta, p. 165)

1. Read the problem carefully, being sure that you fully understand the meaning.
2. Represent, by a variable, each number or quantity to be found.
3. Write an equation (or equations) that gives the relationship between given values and the variables. Sometimes a known formula may be applied directly, often an equation must be written from an analysis of the stated conditions. Equations should state in mathematical symbols the same relationships that the problem states in words.
4. Solve the equation(s) by finding the root (or roots) of the equation(s).
5. Check each root to be sure that it satisfies both the given conditions and the equation.

APPENDIX D
NUMBER PROBLEMS*

1. Twenty-three increased by twice a number is five. Find the number. (87, 5)
2. Multiply by three the difference of 5 minus a number and the result is 27. Find the number. (87,14)
3. The difference between two numbers is 14 and their sum is 8. Find the numbers. (109, 9)
4. The sum of the squares of two consecutive negative odd integers is 202. Find the integers. (188, 3)
5. Find the lesser of two numbers in the ratio of two to eleven, whose sum is -65. (204, 2)
6. The sum of twice one number and five times a second number is 95. The difference between seven times the first number and three times the second number is 25. Find the number. (345, 15)
7. The larger of two numbers is 16 more than the smaller. Their sum is 6 less than three times the smaller. Find the number. (347, 5)
8. Find two numbers in the ratio of 5 to 4 whose squares differ by 81. (401, 2)
9. When 8 is subtracted from twice a certain number, the square root of the result is 2. Find the number. (407, 3)
10. Find two integers whose sum is 11 and whose squares differ by 55. (444, 1)

*All problems come from the Dolciani text unless otherwise indicated. For that reason, I have indicated after each one only page number and problem number in that order.

APPENDIX E
CHEMISTRY PROBLEMS

1. A druggist has 20 grams of a 10% solution of alcohol. How many grams of a 6% alcohol solution must be added to form an 8% alcohol solution? (235, 7)
2. A certain alloy contains 75% copper and a second alloy 35% copper. How many kilograms of the second alloy must be added to 62 kilograms of the first to form an alloy that is 50% copper? (235, 8)
3. How many kilograms of milk testing 5% butterfat and how many kilograms of cream testing 25% butterfat should be mixed to give 100 kilograms testing 20% butterfat? (235, 9)
4. How many kilograms of a 25% silver alloy must be melted with how many kilograms of a 55% silver alloy to obtain 30 kilograms of a 32% silver alloy? (235, 10)
5. How many kilograms of water must be evaporated from 50 kilograms of a 10% salt solution to produce a 25% solution? (247, 26)
6. How many kilograms of a 35% silver alloy must be melted with how many kilograms of a 65% silver alloy to obtain 20 kilograms of a 50% silver alloy? (247, 27)

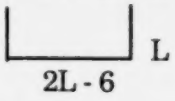
APPENDIX F
INTEREST PROBLEMS

1. A certain sum is invested at 4% annual interest. If $1400 is added to the account, the annual interest will amount to $196. How much was originally invested? (237, 7)
2. The Stanford Company had $6800 in an account at 4% annual interest. They withdrew some money to buy furniture, and the remaining funds drew $172 annual interest. How much did they withdraw? (237, 8)
3. The Downeys invested part of $7000 at 4% and the remainder at 5%. Their annual income from the two investments was $330. Find the amount they invested at each rate. (237, 9)
4. A sum of money was invested at 6% per year, and 5 times as much at 4% per year. How much was invested at each rate if the annual return totaled $312? (237, 10)
5. A sum of money was invested at 4% per year, and a sum twice that amount at 5% per year. How much was invested at each rate if the annual return totaled $70? (247, 28)
6. An investment counselor has an income of $280 per year from two stocks. Stock A pays dividends at the rate of 5% and stock B at the rate of 6%. If the total investment is $5000, how much is invested in each stock? (352, 7)
7. A company takes loans from two banks. It borrows $300 more from the bank which charges 7% interest than from the bank which charges 8% interest. If the interest payments for one year are $126, how much does the company borrow at each rate? (353, 9)
8. Calvin Cook loaned $9800, part at 5% and the remainder at 6%. If each rate of interest had been interchanged, his annual interest would have been only $2 less. Find the amount loaned at each rate. (479, 6)

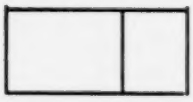
9. The Satos loaned a specific amount at 6% and twice as much at 4%. They received one-third more interest from the sum loaned at 4% than from that loaned at 6%. Their total yearly interest is $490. Find how much they have loaned at each rate. (479, 7)
10. A woman has $6000 to invest, and intends to obtain an income of at least $300. What is the largest amount she can invest at 4% if she invests the balance in a riskier investment at 6%? (479, 8)

APPENDIX G
PERIMETER, CIRCUMFERENCE, AREA

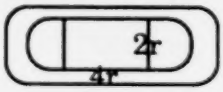
1. The edges of a long rectangular sheet 30 centimeters wide are bent up at right angles to form a trough whose width is 6 centimeters less than twice its height. What is the height of the trough? (106, 12)



2. The Katzes have 250 meters of fencing with which to enclose a rectangular plot and divide it into two parts with a fence parallel to the shorter sides. What should the dimensions of the plot be if it is to be 15 meters longer than it is wide? (106, 17)



3. The figure shows a running track. The infield consists of a rectangle twice as long as it is wide and two semicircles. The track itself is 7 meters wide and has area 1354 square meters. Find the inner radius of the semicircular end of the track. Use 22/7 for . (132, 8)



4. A corner lot had dimensions 20 by 40 meters before it lost two strips of equal width when the adjacent streets were widened. Find the new dimensions of the lot if its area is now 525 square meters. (188, 10)

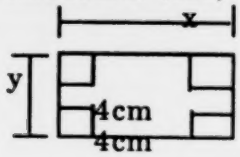
5. The ratio of the length of a rectangle to its width is 7:2. If the perimeter of the rectangle is 396 centimeters, find its width. (204, 10)

6. Find the diameter of a circular plot that has the same area as a rectangular one that is 22 meters wide and 35 meters long. (393, 4)

7. A rectangular doorway is 200 by 75 centimeters inside dimensions. Could a circular mirror measuring 220 cm in diameter be gotten through the doorway? (397, 6)

8. A billboard measures 3 meters by 4 meters. A border of uniform width is painted around the outer edges of the board in black paint. How wide is the border if it covers half the area of the billboard? (444, 4)

9. A box without a top is to be made by cutting squares measuring four cm on a side from each corner of a square piece of cardboard and folding up the sides. If the box is to hold 121 cubic cm, what should be the length of a side of the cardboard? (484, 4)



APPENDIX H
JOB PROBLEMS

1. It takes one man 10 hours to do a certain job. After he has been at work for 4 hours, another man is sent to help. The two men then complete the job in two more hours. How long would the second man have taken to do the job alone? (245, 9)

2. Maria can paint the walls of an apartment in 8 hours. After she has worked 3 hours, Pat joins her and they finish the job in 2 hours more. How long would it take Pat to do the whole job without the aid of Maria? (245, 10)

3. A filler pipe can fill a tank in 12 hours, while an outlet pipe can empty the tank in 18 hours. How long would it take to fill the empty tank with both pipes operating? (245, 11)

4. A tank is fitted with two pipes. One can fill it in 8 hours. After it has been open 2 hours, the second pipe is opened and the tank is filled in 2 hours more. How long would it take the second pipe alone to fill the tank? (245, 12)

5. It takes one printing press 7 hours to do a certain job. After the first press has been at work for 4 hours, another press is put to work. The two presses then complete the job in 1 hour more. How long would it take the second press to do the job working by itself? (247, 30)

6. One pipe can fill a tank in 12 hours and another can fill the tank in 8 hours. How many hours will it take both pipes together to fill the tank? (368, 47)

7. A tank can be filled in 9 minutes when both of two intake pipes is open it takes 15 minutes. How long would the second pipe alone take to fill the tank? (478, 73)

APPENDIX I
DISTANCE PROBLEMS

1. At 8:00 A.M. Jill and Tom start on a hike at 4 km/h. At 11:00 A.M. their mother discovered that they had forgotten their lunches and started after them in her car at 64 km/h. When does she overtake them? (242, 7)

2. A power boat can travel upstream on a river at 24 km/h and downstream at 30 km/h. How far upstream can it go if the round trip is to take 3 hours? (242, 8)

3. The Thompsons averaged 60 km/h in driving from their house to the airport, but they arrived 10 minutes late. If they had averaged 96 km/h, they would have been five minutes early. Find the distance from their house to the airport. (242, 9)

4. A car and a train leave St. Louis at the same time, bound for Hillsboro. The train averages 75 km/h, and the car 100 km/h. The driver of the car stopped for a 2-hour dinner, and arrived in Hillsboro 1 hour after the train. How long did the trip last? (242, 10)

5. Henry can row 12 kilometers downstream in the same length of time it takes him to row 5 kilometers upstream. If the current in the river flows at 6 kilometers per hour, how fast does Henry row in still water? (247, 29)

6. George Kraz found that his small airplane cruised at 5 times the rate of the wind. If he flew 220 kilometers against the wind in one-half hour less time than he flew 660 kilometers with the wind, what was the speed of the wind? (481, 10)

7. A plane has a 6-hour supply of gasoline. What is the greatest distance it can reach from the airport if the speed going is 240 kilometers per hour and the speed on the return trip is 260 kilometers per hour? (481, 14)

8. Lon and Connie live in cities which are 350 kilometers apart. If they drive toward each other, they will meet in 2 hours. If they drive in the same direction, it will take Lon 10 hours to overtake Connie. Find the rate at which each can travel. (481, 15)

9. Suzanne sailed her boat 6 kilometers across Lake Frazer and then sailed back. If her rate returning was 2 kilometers per hour less than her rate going, and if the entire trip took 2 1/2 hours, what was her rate each way? (445, 6)

APPENDIX J
MISCELLANEOUS PROBLEMS

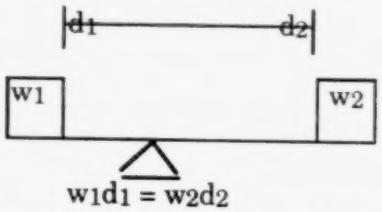
1. If the Panama Canal, opened in 1914, were 2 kilometers longer, it would be half as long as the Suez Canal, which was opened 45 years earlier. How long is each canal if their combined length is 250km? (109, 12)

2. A grower has 50 tons of melons in a field and can sell them now at $40 a ton. For each week she waits, the crop will increase by 10 tons, while the price per ton drops by $4. When should she sell the crop to obtain $2160 for it? (Two answers) (189, 24)

3. A customer received a 20% discount on a suit during a sale. He also received a 4% discount on the sale price for paying cash. If he paid $80.25 for the suit, what was the regular price of the suit? (231, 17)

4. The manager of a theater knows that 900 tickets were sold for a certain performance. If orchestra tickets sold for $3 each and balcony tickets for $2 each, and if the total receipts were $2300, how many of each kind of tickets were sold? (345, 2)

5. Two weights balance when placed 3 meters and 4 meters from the fulcrum of a lever. If the positions of the weight are interchanged, the smaller one would have to be increased by 7 kilograms in order to maintain balance. Find each weight. (345, 6)



$w_1d_1 = w_2d_2$

6. Professor Alvarez can grade set of examination papers in 2 hours, but her assistant requires 2 1/2 hours. After working together for an hour, Professor Alvarez left to attend a meeting and her assistant completed the grading. How long did it take the assistant?

7. If 10 skilled laborers and 15 unskilled laborers work together, they can complete a construction job in 12 days. The same job can be done in 6 days by 25 skilled laborers. How long should it take one unskilled laborer, working alone to complete the job? (481, 2)

8. Electrical waves have a length, D, given by the formula $D = 1884\sqrt{LC}$, where L and C are electronic measures. What value of L will give a wave length of D = 3768 when C = 1?

9. One baseball team has won 5 games out of 17 played and another team has won 6 games out of 12 played. How many consecutive games must the first team win from the second in order that their averages of games won may be

equal? (Vannatta, 422, 16)

10. The sum of the numerator and denominator of a certain fraction is 8. If 2 is added to the numerator and to the denominator, the value of the fraction is increased by 4/35. Find the fraction. (Vannatta, 422, 15)

APPENDIX K
POST-TEST

1. Two numbers are such that their sum is 40 and their difference is 4 more than the smaller. Find the numbers. (347, 4)
2. How many kilograms of water must be evaporated from 100 kilograms of a 6% brine (salt and water) to obtain a 20% brine? (235, 6)
3. The local bank offers 5 1/2% interest on saving, while a certain savings and loan company pays 6 1/2%. How much less (simple) interest over a 5-year period, on $2500, would you receive from the local bank? (237, 6)
4. When a ditch 2 meters wide and 1 meter deep was dug around a square building (and adjacent to it) the volume of earth removed was 192 cubic meters. Find the dimensions of the building. (132, 6)
5. A tunnel is to have a rectangular cross section twice as wide as it is high. Its walls are of reinforced concrete 1 meter thick and its roof is of concrete 2 meters thick. The cross-sectional area of the concrete is 62 square meters. What are the width and height of the rectangular hole needed to accommodate the tunnel and its walls and roof? (132, 2)
6. One pipe can fill a tank in 4 hours. A second pipe can also do it in 4 hours, but a third needs 6 hours. How long would it take to fill the tank if all three pipes were open? (245, 8)
7. At 8:00 A.M. Jill and Tom start on a hike at 4km/h. At 11:00 A.M. their mother discovered that they had forgotten their lunches and started after them in her car at 64 km/h. When does she overtake them? (242, 7)
8. A swimmer takes 1 1/2 hours on a 1-km round trip. On the return trip against the current, 1/8 km took the same times as 1/2 km did on the trip downstream. Find the swimmer's rate in still water and the rate of the current. (359, 12)
9. For a school play 738 tickets values at $856 were sold. Some cost $1 and some cost $1.50. How many tickets were sold? (Holt, 82, 11)

10. The perimeter of a rectangle is 24 m. The area of the same rectangle is 35. Find the dimensions. (Holt, 439, 21)

Shapes
In
Your
Life

Nellie Pruitt

Shapes in Your Life
Nellie Pruitt

RATIONALE

The purpose of this unit is to help the student discover that everything we see around us has shapes that are endless variations on the same common forms. Unusual and complicated shapes are extensions and combinations of the circle, square and triangle. These simple shapes have proved themselves functional and repeat themselves again and again. Beauty is achieved by the use of these shapes in patterns of symmetry.

These shapes should be studied because basic beginnings of life have to do with the discovery of these shapes and they are applicable in every phase of life. Nature first used these shapes to build our world, and show us beauty. Because they are so functional, the navigator and the astronomer use them as basic units in their professions. The circle, square, and triangle each have a distinct character of its own, but can be used in combinations to form more elaborate shapes with new and unique properties.

Since gifted students have the ability to see relationships, discover new applications and invent new products, they should study the basic shapes to make themselves aware of something that so basically affects their lives.

This unit is geared for fifth grade gifted and talented students although it may be modified for fourth and sixth grades. It is designed to cover a period of three to four weeks. It can be used to coordinate geometry, science, art, and career education. Also, it may be used as an independent study for those gifted and talented students in the regular classroom.

OBJECTIVES

At the conclusion of this unit the student will be able to:

1. Locate and identify circles, squares, and triangles in their home, school, and community.

2. Recognize the functional use of shapes in forming simple structures.

3. Recognize that the simplest form--the triangle--is used in many ways in nature and by man in his inventions.

4. Recognize that the square and rectangle are used extensively by man for designs for shelter, games, etc.

5. Recognize that the circle is abundantly used in nature for beauty, efficiency and economy, and that man adopted the circle for the wheel.

6. Understand that the plane figures of circles, squares, triangles, can be expanded into solid geometry, e.g. circles become spheres or cylinders, triangles become cones or pyramids, squares become cubes.

7. Curves in many variations of form and size can be seen in nature, are used by man in industry, and to decorate pottery, walls, clothing, and buildings.

8. The shapes and the lines that make them are used to show perspective or the illusion of depth on a flat surface.

9. Realize that our feelings are deeply affected by shapes, e.g. violence and unrest with angles and jagged lines, contentment and ease with horizontal lines and gradual curves, stimulation with spirals.

10. Scientific ideas of sound, movement of heat are explained using shapes.

ACTIVITIES

INTRODUCTORY

1. Define, draw, and label circle, square, and triangle.

2. Construct a design puzzle using only triangles. Count the triangles, organize and color groups of triangles to produce a design.

3. Classify items in the classroom under the headings:
CIRCLE SQUARE TRIANGLE.

4. Exhibit pictures of buildings and have the student find examples of squares, circles, triangles.

5. Exhibit picture of living things, identify basic shapes, explain how and why certain shapes are joined together.

6. Give pretest of discovering and labeling basic shapes in a picture. (Repeat test at the end of the unit and have student compare the progress made in recognizing shapes.)

7. Show filmstrip: "Areas, Geometric Figures", "Advancing in Geometry", "Geometry-Perimeters, Areas, Space Figures". Show the film: "Geometry and You".

DEVELOPMENTAL

1. Discover and draw the use of basic shapes in simple shelters. Explain reasons for using these shapes, e.g. tools, knowledge, location, how earn a living.

2. Research shapes of primitive houses. Prepare a written report with diagrams to explain the conditions that caused them to use that particular shape, and the effect of using it.

3. Explain causes of more complex houses, and the form of the more complex house.

4. After collecting empty boxes and food packages, label the shapes, discuss the relationship of the shape to each other, make a graph showing which shapes are used together.

5. Research the shapes of bridges, explain the advantages of different designs and why each would be used. Make a speech to the class, using diagrams to illustrate different designs.

6. Analyze packages for different products and explain the package's suitability for that product. Discuss pros and cons, product breakage, rigidity, ease of packing and moving, relation to product, esthetics, etc.

7. Select five different types of buildings in our community. Sketch these and find examples of shapes in the exterior surface of the buildings.

8. Take a walk down five stations of our nature trail. List, draw, and label examples of circles and curves. Then walk around the buses and the parking lot. List, draw, and label examples of circles and curves that man has used in machines. Are they used for function or beauty?

9. After identifying the basic shapes in pictures of living things, draw these living things using the pure form of the basic shape. Distinguish the relationship between the real object and your drawing.

10. Study designs in clothing of students in the classroom. Identify shapes, repetition of design and then create a repeating design using the basic shapes. What would be a good use for your design? (fabric, wallpaper, upholstery, etc.)

11. Examine pictures of Indian art as used in pottery, basketry, jewelry, and blankets. Identify external shapes and shapes of designs, write the relationships between the shape of the object and the shape of the design. What was the significance of the design to the Indian? How does that significance relate to the shape of the design?

12. Examine pictures of Indian art prints for perspective. Find examples of parallel lines coming together, effect of distance on relative size. Then use the ideas of perspective and foreshortening in a picture of your own. Why does the eye tell us that the lines get closer together as they get farther away, while the brain tells us that they remain the same distance apart?

13. Examine the comics from the newspaper. Chart your emotions when looking at various types of comics. Then search for shapes related to your feelings. Did particular shapes suggest particular emotions? (See objective 9)

14. Rhythm is movement. Lines moving in repeating patterns are used to illustrate rhythm. Locate many varieties of rhythm in nature and relate them to objects made by man. How did man adapt these rhythms for his use?

15. After studying lines of symmetry, sketch objects in the classroom that contain

lines of symmetry and indicate symmetry. What is the basic shape of these objects? Does having a line of symmetry make the object more pleasing to the eye?

16. After studying angles estimate heights of walls, trees, electric poles with a mirror. Do measurements, calculations, and diagrams to prove your answer. Make a poster of your activity and explain to the class. Do the same activity using 12 inch ruler or a yardstick and a tree.

17. Recognize the functional use of the triangle to build a sturdy structure by preparing a demonstration illustrating the flexibility of the rectangle and the rigidity of the triangle. Then construct a model using only rectangles and demonstrate how it could be strengthened by modifying the design to include triangles.

18. Invite a builder to speak to the class about the use of triangles. What particular parts of the building require triangles?

19. Recognize that plane (flat) figures do not have the ability to support weight but that they can be folded, rolled, etc. and made to support weight. Devise an experiment to illustrate this principle, and present it to the class explaining why altering the shape improves support. Can you look around the classroom, look at food packages, etc. and find examples of this concept?

20. After learning the commands and concepts of LOGO, write a procedure to make the Turtle draw the three basic shapes. You may place them anywhere on the screen and repeat them if you like.

21. After discovering the concept of congruency (figures of the same size and shape), construct a design using a shape turned in many directions and reversed. (slips, slides, and turns) Exchange with a friend and find all the congruent figures. Then identify with a symbol the forward facing point of the figure.

22. To discover the relationship in the basic shapes to solids, construct the five Platonic solids. Analyze the faces of the solids to find recurring shapes, length of sides and measure of angles. Explain why a particular shape makes a particular solid. Try doing the same procedure with the thirteen Archimedean solids. Why are they called Platonic and Archimedean solids?

23. Visit and interview an architect to discover how he uses the basic shapes in designing buildings. Take lots of notes or use a tape recorder (if the person is willing). Prepare a presentation for the class citing major ideas you learned and some unusual facts. Explain "Why (or why not) it would be fun to be an architect." What are some subjects an architect must study?

24. Visit the Hickory Museum of Art with your parents. Point out to your family the basic shapes in several of the paintings. Then interview the museum director, asking questions about artists' use of basic shapes, perspective, foreshadowing. Report you findings to the class and use art prints from the school picture file.

25. After visiting a building supply store and researching materials used in construction of buildings, relate the materials to specific shapes. Which material is used for squares, for circles, for triangles? Can they be adapted for that shape?

26. Using the three basic shapes, design a portrait of yourself. Explain why you used specific shapes for specific parts of your portrait. Can you find any relationships between the shapes and other parts of the body? Can you use them to make a full length portrait?

CULMINATING

1. Select a food package that, in your opinion, does not suit its product. Design and construct a new package to meet previous standards and include ease of opening and economy of materials in your design. Be able to explain your reasoning.

2. Research and explain to the class how sound can be illustrated by curves in lines. Cite uses of this in medicine. Devise an experiment to demonstrate your ideas.

3. Explain the shapes of your food package collection, showing that circles became cylinders, triangles became ones or pyramids, squares became cubes. Design a package that is an exception to this. Explain how you would accomplish this.

4. Examine diagrams of machines that travel on wheels. Identify basic shapes, then combinations of basic shapes, to meet special needs of the machines. List problems solved by unique combinations or additions or shapes.

5. Collect leaves of many shapes. Examine each leaf for basic shape, combination of shapes, lines of symmetry, etc. Group for these characteristics and chart your results. Present to the class and explain your findings.

EVALUATION

1. Repeat the pretest of discovering and labeling basic shapes in a picture. Using both tests, have the student evaluate his progress in recognizing shapes.

2. Plan a drawing lesson for the class illustrating that artists use basic shapes as beginning points. Present the lesson to the class, collect their papers, and evaluate the results. What could you have done to improve your lesson?

3. Plan, organize and execute an art lesson on perspective. Collect the papers and evaluate the results. What could you have done to improve your lesson?

4. After studying angles, and degrees in a circle, practice surveying. Make a simple transit to find angles, take a friend and the necessary equipment to the

football field and lay out different kinds of shapes. (Appendix 3)

5. After writing procedures in LOGO for different designs, write nesting procedures. Demonstrate your procedures on the computer and add color. Save your procedures on a disk.

6. Research cubism and abstractionism as art forms. Show examples from the school library print collection, explaining the features of these forms. After this explanation, get your classmates to create an original picture using a variety of shapes to achieve their design. Collect these and ask a person knowledgeable about art to judge them. Display the winners in the library.

7. Using the shapes in "Geo-Ring Polyhedra" sourcebook, design and construct an original shape. Give its purpose, explain its construction, list materials to use. Invite an architect to evaluate the shape. Display shapes in the library.

8. As you ride home on the schoolbus, observe the buildings along your route. Locate the basic shapes in exteriors, identify different building materials, summarize the relationship between shape and material. Locate unique uses of materials, unique combinations of materials. Sketch the buildings and indicate on your sketch: shapes, materials, unique materials, location. Are these combinations for function or esthetics?

HOME LEARNING ACTIVITIES

1. The student and parent will tour their home to locate examples of basic shapes. List the number found in each room at the beginning of the unit and again at the end of the unit. Did the student show more perception after studying shapes?

2. The student and parent will compare shapes of buildings within sight of his home and identify shapes, building materials, uniques designs. Can you see beauty in these buildings? Why or why not?

3. The student and parent will construct simple models of homes using "found" materials. How original can you be in designing this model and what unusual materials were used?

4. The student and parent will drive to a bridge, get out of the car and examine the structure from underneath. Use the I40 bridge near Mtn. View School. Can you locate the structural designs necessary for proper support?

5. The student and parent will examine food packages in the kitchen. Group these packages according to shape and compare shape to characteristics of content. Can you design a better package for that product? Can you design a better feature of that package?

6. The student and parent will analyze designs of furniture---especially chairs. Have unique shapes been used for the chair? Have unique materials been used for

the chair? Can you design a chair using unique shapes and materials? Will it be comfortable?

7. The student and parent will make a collection of advertisements from magazines. Can you group them according to shape? How do different shapes make you feel? Would you want to buy that product? Would you recognize that product if you only saw the silhouette?

8. The student and parent will locate examples of rhythm in their home e.g. moulding around room, wallpaper patterns, designs in fabrics, walks, etc. How does rhythm contribute to beauty in the home?

9. The student and parent will locate and group simple kitchen tools for basic shapes. Find also angles, curves, lines of symmetry.

10. The student and parent will use the simple surveyor's transit to lay out games areas on the lawn, small gardens, etc.

11. The student and parent will visit a building supply store in our community. Examine the wide variety of building materials. Do these materials have specific uses? Which are interior and exterior and why? How do the textures of the materials feel? Which texture would you like to have in your home?

12. The student and parent will visit a Museum of Art. Identify shapes in paintings, ask museum personnel to point out perspective and other techniques used by the artist to create an illusion of depth on a flat canvas.

13. The student and parent will participate in a practice art lesson. The student will practice giving clear explanations and instructions for his presentation to fellow students.

14. The student and parent will estimate heights of walls, pictures, lamps, etc. in the home using a mirror. The student will teach the parent how to do measurements, calculations, and diagrams to prove the answer.

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THE HOUSE WITH THE SECRET ROOM, Eunice Young Smith

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LET'S BUILD A HOUSE, Billy N. Pope and Ramona Ware Emmons
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Logical Reasoning

Brenda Hughes

Logical Reasoning
Brenda Hughes

Introduction

A great majority of students in school today seem to lack any type of logical reasoning. They may arrive at an answer, but not be able to explain the method of arrival. This unit is designed to help the student think more logically and in doing so, arrive at carefully analyzed conclusions. It is designed as a beginning topic for high school geometry students (academically gifted) but could possibly be adapted for use in an average or below average classroom and also for junior high level.

Although the focus of this lesson is on deductive reasoning and the logical process thereof as used in geometry, inductive reasoning has also been introduced. Some recent research has found that most kinds of concepts taught in school involve the left hemisphere of the brain. But such things as recognition of patterns, the ability to generalize, and consequently some parts of inductive reasoning appear to involve the right hemisphere. You, as a teacher of the gifted, may want to encourage these students to explore inductive reasoning a great deal more for answers to questions such as "What would happen if" and "What can be done about," etc. Wherever the emphasis may lie, we can all certainly see the need for both kinds of reasoning.

Objectives

At the conclusion of this unit, the student will be able to:

1) Distinguish between deductive and inductive reasoning and realize the need for both types.
2) Be able to use deductive and inductive reasoning in making decisions both in and out of the classroom.
3) Understand and use Venn diagrams as a demonstration of reasoning.
4) Develop tables of logic (truth tables) using symbolisms.
5) Use the concepts learned as a basis for proofs in Geometry.

Activities

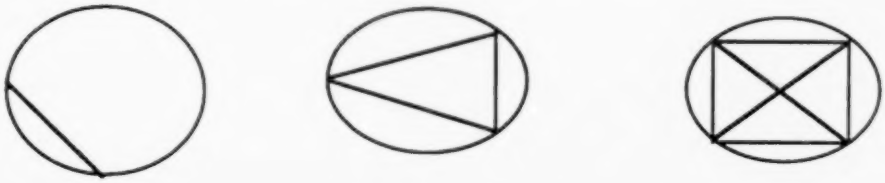
Introductory

1) Administer a pre-test "Are You Logical?"
2) Give students the Balance Pan Puzzle. This puzzle was posed by one of America's greatest puzzle experts, Sam Lloyd. The questions show how guessing can lead to a solution.

Developmental and Culminating

Note: Developmental and culminating activities are grouped within each topic in order to maintain continuity. Culminating activities are marked with an *.

1) Explain inductive reasoning with the following activity: Her is a set of three circles:



Two points have been chosen on the first circle and a straight line segment drawn between them. The circle is separated into two regions as a result. Three points were chosen on the second circle and were connected with 3 line segments forming 4 regions, etc. 1. Guess from the pattern how many regions are formed when 5 and 6 points are connected. 2. Draw a couple of large circles and choose 5 points on one and 6 on the other. Join the points in every possible way. 3. How many regions are formed on each? 4. Do both results agree with your guesses?

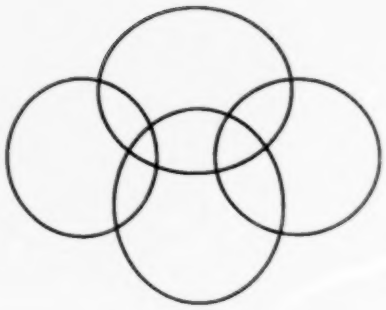
2) Explain deductive reasoning and assign the 3 hats experiment.

3) Compare and contrast deductive and inductive reasoning using the following questions and projects. * 1. Which type of reasoning would someone have been using if they were cautioned "Don't jump to conclusions"? Why? * 2. Which type of reasoning is analogy? Intuition? Geometric direct proofs? 3. Suppose that a piece of cloth from a coat is found in the hand of a murdered man and that a coat with a piece torn off and belonging to the man's gardener is found in the garderner's own room. What logical principles would support the conclusion that the gardener was the assailant? 4. Take a newspaper story and some songs and analyze them for types of reasoning, etc. *1. One of the most famous applications of inductive reasoning is Galileo Galilee's pendulum. Research this reasoning. Could he have used deductive reasoning and come up with the same conclusions? How? Why or why not? 2. Report on the Leaning Tower of Pisa which is an example of a conclusion from inductive reasoning that proved to be false. 3. Make a report on Cuclid and his contributions to deductive thinking. Why is there a non-Euclidean geometry? What is the need? *4. Deductive Reasoning Challenge: There are three containers that are labeled incorrectly. One contains two nickels, another two pennies and another a nickel and a penny. Explain how it is possible to determine the correct labeling for all three containers by selecting just one.

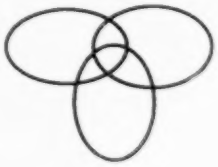
4) Our intuition is often influenced by optical illusions. Discuss mathematical illusions and give some examples. (Parthenon) Introduce some diagrams for students to tell the geometric figure and the illusion.

5) Venn diagrams are representations, usually in the form of circles, of a certain concept, not necessarily restricted to mathematics. In mathematics they can be used in the relationships of sets, their intersection and union, subsets, etc. They are sometimes helpful in representing relationships between sets for the purpose of forming conclusions.

Questions: 1. This Venn diagram of human population was used in investigations correlation the presence or absence of B27 (a human antigen), RF (an antibody protein), spondylitis (an inflammation of the vertebrae) and arthritis (an inflammation of the joints) with the incidence of various rhematic diseases. a) What is the number of the region that corresponds to spondylitis and 27 but not to arthritis? b) What is the number of the region that corresponds to arthritis and B27 but not to RF or to spondylitis? 2. HLA: Take a survey of 50 families in your neighborhood as to: how many have an 85 or '86 car, a dog, a VCR, a VCR and an '85 or '86 car, a VCR and a pet, an '85 or '86 car and a pet, a VCR and the car and a pet. Beginning with those that had all three draw a Venn diagram representing intersection and union of all these sets. a) Write the number of people in the 7 regions. b) How many have a VCR and a pet but not a car? c) How many didn't have a pet, or a VCR, or the car? 3. Her are the results of 120 people which show the television networks they watched in a given evening:



Networks	No. of People
ABC	55
NBC	30
CBS	40
ABC&CBS	10
ABC&NBC	12
NBC&CBS	8
NBC&CBS&ABC	5



a) Write the number of people for the three remaining regions of circles. b) How many people watched ABC or CBS, but not NBC? c) How many people watched CBS but not (ABC or NBC) d) How many people watched NBC and ABC but not CBS? e) How many people did not watch any of those three networks?

6) Logical ways of reasoning may certainly lead us in to the study of logic itself. Before a student can discuss logic, he must have a knowledge of the vocabulary involved and the symbols. He should recognize and understand the following: If p and q are statements:

If-then	
Negation	~
Converse	If p q, then q p
Inverse	~p ~q
Contrapositive	~q ~p
Conjunction	^ or
Disjunction	or

Questions: 1. Write each statement in the if-then form:

a) The boy is a Johnson, if he has red hair. b) All ducks are birds c) Veritcal angles are equal. d) Complements of the sam angle are equal. e) Any two paralles lines are coplanar. 2. Write the converse, inverse, and contrapositive of each statement: a) If we can afford it, then we buy a new car. b) If we play ping pong, then you win the game. 3. Truth tables are used to define the meaning of our symbols and forms of statements. For example, when two statements p and q are involved, we have one implication table:

p	q	p q
T	T	T
T	F	F
F	T	T
F	F	T

Develop your own truth tables for the following: q p, ~p, ~q, ~p ~q, p (q p), (p^q)^[~p ~q.]

*4. In truth tables your first step is to translate word arguments into symbols and prove valid or invalid. Many common fallacies stem from the assumption that the converse and inverse of a true statement is also true. Remember: POSSIBLE false conclusions, true premise VALID. Identify each of the following arguments as valid or invalid and tell why. a) If the sun shines, then I will cut the grass. I am cutting the grass. Therefore the sun is shining. b) If Jane is being married, then she will wear a white dress. Jane is not being married. Therefore Jane is wearing a dress that is not white. c) If x is greater than 3, then x = 7. x is not equal to 7. Therefore x is not greater than 3. d) If $x^2 + y^2$ is less than 9, then x = 2. $x^2 + y^2 = 9$. Therefore x is not equal to 2. e) If a chicken wants to get to the other side of the road, then the chicken crosses the road. The chicken crosses the road. The chicken wants to get to the other side. 5. What is your opinion of this famous affirmation of Blaise Pascal "The heart has its reasons, which reason does not know." *Projects: 1. Of two tribes inhabiting a South Seas isle, members of one tribe always tell the truth, and members of the other always lie. A logician vactioning on the isle comes to a fork in the road and has to ask a vative bystander which branch he should take to reach a village. He cannot tell whether the native is a truth teller or a liar but succeeds in framing a single question so cleverly that he will nevertheless know from the reply which road to take. What question could have served. The following alternatives have been proposed. Justify them 1) "If I were to ask you if this road leads to the village, would you say yes?" 2) If I asked a member of the other tribe whether this road leads to the village, would he say yes?" 3) "Of the two statements, 'You are a liar' and 'This road leads to the village' is one and only one of them true?" Project *2 Suppose that the following rule defines the conditions under which a student will be admitted to the football stadium. "Either he must present a valid Student Identification Card and agree to sit in the student section, or else he must purchase a general admission ticket." Under what circumstances will a student be denied admission to the stadium?

Evaluations

1) Keep a notebook with answers to all questions to be handed in at the end of the unit.
2) Short test on vocabulary and facts.
3) Projects intermingled in the activities will be handed in at the end of the unit.
4) Post-Test: "You're Logical"?
5) Using logical reasoning discuss one of the following: a) Should One Always Do His Best? b) Is It True That Anything Worth Doing Is Worth Doing Well? c) Is Experience Really The Best Teacher?
6) Choose one of the following 2: a) Philosophical Problem Sheet #20 In My Opinion b) Ideal scientific description of any kind of social situation may ask for an exhaustive list of potentially relevant circumstances from which the particular conditions that occur can be named.

Materials (references for teacher)

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Going,
Going,
Gone?

Sandra Ruppe

Going, Going, Gone?
Sandra Rupe

INTRODUCTION

The decline and sometimes disappearance in wildlife population is an undeniable fact of the nineteenth and twentieth centuries. The rate of extinction in the time period of 1850 to 1900 was the equivalent of one species of animal disappearing every nine and a half months. This rate increased to one species becoming extinct every eight months between 1900 and 1950. Since 1950 human population and industrial needs have multiplied greatly, hence, there is a need for more space to accommodate this growth.

Man has changed the world around him. As human population has increased, more and more land has been cleared, lakes and streams have been polluted, and wildlife has often been killed carelessly with little thought of endangerment and extinction. We have crowded the earth and have steadily continued to change it.

More and more people, in recent times, have been working to save our wildlife and thwart extinction. There are many organized groups that work for the protection of wildlife. Biologists emphasize that when wildlife dies an unnatural death, people should take warning. A world that is no longer suitable for wildlife to live in might also become unfit for people. Every living organism is part of an ecosystem of different species surviving together. As one of these species disappears the world is also changed for other plants and animals around it.

The purpose of this unit is to help students develop a better understanding of endangered animals and how to protect them from future extinction. They will be able to develop an understanding of reasons for extinction in the past and apply that understanding to help protect threatened and endangered animals of the present and future.

This unit is designed for use with fourth grade gifted students for a period of approximately 5 to 6 weeks. This unit could be adapted to other grade levels. It can be used in Science and correlated with Language Arts and Social Studies.

This unit is especially important for gifted students. As creative, problem-solving individuals, they have the potential of being able to make a great impact on the protection of our wildlife and human life. With the growth of human population, increasing amounts of pollution, and need for more and more land, we need resourceful people to be able to deal with these problems.

OBJECTIVES

1. Students will be able to identify terms related to endangerment and extinction of animals.
2. Students will be able to identify animals that are extinct and those that are currently endangered.
3. Students will be able to determine reasons for past extinction of animals.
4. Students will be able to predict causative factors for future endangerment and

extinction of animals.

5. Students will be able to evaluate society's contributions to endangerment and extinction of animals.
6. Students will be aware of and be able to evaluate the usefulness of local, state, and national laws for protection of animals.
7. Students will develop a responsible attitude toward present and future animal wildlife.
8. Students will be able to generate ways they or their community can aid in conservation of animals.

ACTIVITIES

INTRODUCTORY ACTIVITIES

1. Arrange for a science center representative to give a presentation on endangered animals.
2. Have a local forest ranger talk to the students concerning local wildlife and their needs for protection.
3. Take a field trip to the Raptor Center in Charlotte, NC or have a representative of the Center give a presentation to the class. The Raptor Center takes care of injured animals and works to return them to nature.
4. Plan a field trip to the a zoo. Place special emphasis on threatened and endangered animals at the zoo.
5. Show the students the set of filmstrips, "Extinct, Endangered, and Threatened."
6. Show the filmstrip, "Wildlife for Tomorrow - The Story of Our Un-endangered Species." This filmstrip explores the success of the American system of wildlife from the brink of extinction and restoring them to healthful and abundant members.
7. Have students construct a Going, Going, Gone? Dictionary using the following words in relation to endangered and extinct animals as their entry words. Illustrations should be used when possible.

   Entry Words - threatened, endangered, extinct, species, climate, environment, habitat, adaptation, pollution, population, acid rain, competition - and any other words considered important to this topic.
8. Have students research and make lists of local, United States, and world wide endangered animals and a separate list of extinct animals. These lists will be useful with following activities in the unit. - Have students construct a chart showing these lists.
9. Provide students with a list of the names and addresses of organizations that work for the protection of animal wildlife. This should be done either preceding the start of the unit or at the first of the unit. Students are to write these organizations for any available information.
10. Prepare a collection of books and current magazines such as Ranger Rick and National Geographic World that contain information on endangered and extinct animals. Have students read articles on specific animals and write summaries or give oral presentations of the articles they read.

DEVELOPMENTAL ACTIVITIES

1. Choose an endangered animal. Write a travelogue telling of the varied travels of the animal as it searches for a new home after its original home has been destroyed. Draw a map to show your travels.
2. Create an editorial cartoon telling of the plight of endangered animals.
3. Choose five endangered animals. Construct a food web for each.
4. Organize a fact file on endangered and extinct animals. Include illustrations.
5. Find out the present day symbol for "Vanishing Animals". Create a new one.
6. Imagine that you are an endangered animal. Choose one from your list. Write a newspaper ad giving your personal requirements for a home. Be sure to give location needed, size desired, and other necessary information. Check local newspapers for suggestions as to ad format.
7. Research early American Indian's feelings about use of animals. Research the same for early settlers. Compare and write a report of your results.
8. Do animals have rights? Evaluate your feelings on this subject. Write your views in editorial form that could be sent to your local paper.
9. Produce an editorial for a newspaper concerning use of land and/or hunting as it affects animals. Write the editorial from the point of view of the animal.
10. Interview a local Forest Ranger concerning rules and regulations for hunting and fishing. Question the Ranger as to how these rules and regulations can and have protected our wildlife. Pretend you are a television reporter. Orally tell of your interview and what you learned.
11. Using any available printed material and by contacting appropriate people make a list of the names of all jobs or types of employment related to the protection of animals that a person could have. After compiling your list, choose three jobs that you think you would enjoy and give your reasons for your choices.
12. Research extinct animals and the reasons for their extinction. Construct a chart showing animal, habitat, food and reason for extinction.
13. Research endangered animals and the probable cause of their endangerment. Construct a chart showing animal, habitat, food, and cause for endangerment.
14. Given a list of 20 animals, classify them as to threatened, endangered, or extinct. Show this on a chart.
15. Using the vocabulary words from Introductory Activity #7, create a Concentration type game.
16. Research animal fossils as related to extinction. Use a material such as plaster of Paris or clay and items such as shells, teeth, or animal bones to make fossils. Make a display of your work for your class. Include a short explanation or fossils.
17. Investigate the roles that zoos play in the preservation and propagation of the earth's vanishing animals. Write or give an oral presentation concerning your findings.
18. Produce an imaginary TV talk show. You will need a host, a zoo official, a Forest Ranger, an official of a wildlife protection organization, and a

lawmaker. Have the host lead a discussion concerning how we are presently controlling wildlife endangerment.

19. Choose a famous person connected to the preservation of wildlife. Find out as much as you can about the life of this person and their interest in wildlife preservation. Make a tape of your findings for others to listen to. You may choose one of the following or use any other appropriate person - John Audubon, John Birch, Theodore Roosevelt, Martin Perkins, Marty Stouffer, Robert Redford, Jane Fonda.
20. Take a walk around your home and school. Find and observe animal homes. Decide what future things could happen that would threaten these animal homes. Record your thoughts.
21. Using various resources and maps, find locations of national parks and protected reserve areas in your state and in neighboring states. On a blank map of your state and neighboring states, show these locations by use of a key or legend.
22. Choose five extinct animals. Write an epitaph for them.
23. Compare and contrast numbers of specific animal species living in the past/present. Develop a graph to show your results.
24. Un-endangered species are those species that were endangered but due to the efforts of wildlife management, they are no longer considered endangered and their numbers have increased. Choose one of the following un -endangered animals. After researching this animal, either write a news article or produce an editorial for a radio program telling why this animal was at one time considered endangered, factors that caused the endangerment, numbers of animal now and then, and what caused this increase in number. -- elk, pronghorn antelope, trumpeter swan, wild turkey, wood duck.
25. Construct a time line, going back in time as far as possible, showing passage of laws in the United States concerning protection of animals and hunting and fishing regulations, etc.
26. Pretend that you have written a book for children on protection of animal wildlife. Design a cover for your book.
27. Create a stamp that would help increase public awareness of animal endangerment and extinction.
28. Invent a new game dealing with animals that are currently endangered or extinct.

CULMINATING ACTIVITIES

1. Find out about endangered species in your area. Write letters to local newspapers, radio stations, and politicians concerning your views.
2. Bob Barker, longtime host of the Miss USA Pageant, is an animal rights activist. Barker threatened to walk away from the pageant finals if contestants wore fur coats during a production number. As a result of Barker's stand, imitation fur coats were used. Evaluate your feelings concerning Barker's stand for animal rights. Write a letter to Bob Barker telling him of your feelings.

3. Men who worked in coal mines deep under the surface of the earth once carried a canary in a cage with them into mines when they went to work. The miners worried about poisonous gases that might kill them. The gases would kill the canaries first. The canary was used as their early warning system. Lead a group discussion about endangered and extinct animals as an early warning system for humans.
4. In earlier days there was a great population of passenger pigeons in the United States. Now there are none. They are extinct. Research information concerning the passenger pigeon. Produce a play or puppet show - the setting being a September day in 1914 at the zoo in Cincinnati, Ohio. Your main character will be Martha, the last passenger pigeon, who died on this day in 1914.
5. Invent an extinction-proof animal. Decide what it would look like, where it would live, what it would eat, and how it would act. Draw a picture and give the species a name. Write or give an oral presentation about the animal.
6. Read a copy of the current "N.C. Inland Fishing, Hunting, and Trapping Regulations Digest". Evaluate the stated rules and regulations. Make a list of any recommendations or changes that you feel should be considered. Send a letter stating your concerns to the N.C. Wildlife Resources Commission.
7. Find out about endangered species in your area. Write letters to local newspapers, radio stations, and politicians stating your concerns.
8. Compose a song or poem with the purpose of letting others know about endangered animals. Record it on tape and check to see if a local radio station would be interested in using it.
9. Write and illustrate a book dealing with endangered and extinct animals. Include specific animals, their plight, and what is being done to try to help these animals. Share book with younger children.
10. After researching threatened, endangered, and extinct animals, predict two animals that might, in the future, be added to the list of endangered animals if precautions aren't taken now.
11. Using your predictions from #10, develop a plan to protect these animals and keep them from being added to the list. Conclude your ideas in the form of a recommendation.
12. Imagine that you are a member of a political lawmaking body. Based on your feelings concerning endangered and extinct wildlife, propose two laws that you would present to the law-making body.
13. Imagine a world that didn't endanger animals. Write an advertisement trying to sell people on the idea of moving to this new world.
14. Pet stores transporting and selling rare species and exotic animals may lead to endangerment. Write a letter to the local newspaper, politicians, and pet store owners about possible endangerment.
15. Write letters of protest to government officials of nations still engaging in commercial whaling.
16. React to the statement that man is destroying himself by over populating the world. Will there be enough food for the future? Are famines, plagues, and wars nature's way of restoring a balance to nature? Record your feelings on these topics.

17. Compose five eye-catching slogans concerning preservation of wildlife. Make posters using these slogans.
18. Find the closest wildlife organization that works for the preservation of animals. Attend a meeting. Write an evaluation of the meeting.
19. Conduct a mock trial. Have some students be people that want to clear land to use as farmland, for lumbering, or for housing developments. Other students are to act the roles of animals that live in this particular habitat. Both sides present their defense. A third group of students will act as the jury and will decide the outcome of the trial.
20. Create five eye-catching, message-giving bumper stickers.
21. The skins of such animals as alligators and crocodiles are used in making belts, shoes, handbags, and other such items. What are your feelings concerning this? Find someone to share your feelings with.

EVALUATION

1. Working with other students using the "Going, Going, Gone" unit, produce a newspaper dealing completely with threatened, endangered and extinct animals. Use usual newspaper format including name of paper, headlines, current happenings, pictures, editorials, advertisements, classified ads, obituaries, etc.
2. Produce a puppet show making younger students aware of endangered and extinct animals and reasons for their plight. Include in your puppet show possible ways to help prevent further endangerment and extinction.
3. Contact local radio station. If allowable, produce and present a radio spot designed to increase public awareness of endangered and extinct animal wildlife.
4. After working through this unit, acquiring vast background information, and formulating ideas of your own, organize a panel to debate the following topics and also some of your own.
   - - Zoos or not zoos?
   - - Progress or protection?
   - - People or nature?

   Make a video of the debate for others to view.
5. Help to organize an Animal Wildlife Conservation Club at your school. Work toward informing others and keeping up to date on issues relating to protection of animal wildlife. Generate ways you can take part in wildlife protection.
6. Design and produce a pamphlet concerned with awareness and protection of endangered and extinct animals.
7. To inform other students of the plight of endangered and extinct animals, set up a Gallery of Endangered and Extinct Animals in a visible place in your school. Use posters with pictures of animals and written information. Make available addresses of animal wildlife conservation groups.

Many of the activities listed under Culminating Activities could be used as an evaluation. Also, the activities listed under Evaluation could be a part of Culminating Activities depending on the students and teachers using this unit.

RESOURCES

Filmstrips

"Extinct, Endangered, and Threatened." Pomfret House. (6 filmstrips and guide included)

"Wildlife for Tomorrow". International Association of Fish and Wildlife Agencies.

Educational Television Programs

Educational television programs or videos of these such as, "Animals and Such", "National Geographic", "Wild Kingdom", etc., that deal with endangered or extinct animals can provide information and insight.

Pamphlets

"Endangered Species". Department of the Interior. U.S. Fish and Wildlife Services.

"Endangered Species at the North Carolina Zoological Park". North Carolina Zoological Society, Inc.

"North Carolina Inland Fishing, Hunting, and Trapping Regulations Digest. North Carolina Wildlife Resources Commissions". (512 N. Salisbury Street, Raleigh, North Carolina 27611)

Magazines

There are various magazines that could be used as resources for this unit: National Geographic World, Ranger Rick, Wildlife in North Carolina, National Wildlife, Zoobooks, and Carolina Notebook publication.

Free subscriptions are available to Carolina Notebook by writing the Division of Conservation Education, North Carolina Wildlife Resources Commission, 512 North Salisbury Street, Raleigh, North Carolina, 27611.

Books

Allen. Vanishing Wildlife of North America. National Geographic Society.

Anderson. Animals in Danger. Frederick Warner Publishing.

Branley. Dinosaurs, Asteroids, and Superstars; Why the Dinosaurs Disappeared. Crowell Publishing.

Burton. The How and Why Wonder Book of Extinct Animals. Grossett and Dunlap.

Fields. Seals. Franklin Watts.

Goodenough. Dinosaurs and Prehistoric Animals. Watertower Books.

Gould. Animals in Danger in Europe. Rourld Corporation.

Hendrick. Saving America's Birds. Lothrop, Lee, Shepard Books.

Hoffman. Panda - Animals in the Wild. Raintree Publishing.

Hoffman. Tiger - Animals in the Wild. Raintree Publishing.

Lampton. Mass Extinction: One Theory of Why Dinosaurs Disappeared. Watts Publishing.

Laycock. The World's Endangered Wildlife. Grosset and Dunlap Publishing.

National Geographic Society. Animals in Danger. National Geographic Society.

Raintree Publishing. Let's Discover the Prehistoric World (Warm-Blooded and Cold Blooded Animals). Raintree Publishing.

Rourke Publishing. The Great Book of Animals. Ray Rourke Publishing Company.

Serventy. Crocodile - Animals in the Wild. Raintree Publishing.

Serventy. Elephants - Animals in the Wild. Raintree Publishing.

Serventy. Whale and Dolphins - Animals in the Wild. Raintree Publishing.

Stone. Endangered Animals. Children's Press.

Stuart. Wildlife Alert! The Struggle to Survive. National Geographic Society.

Encyclopedias

Illustrated Encyclopedia of the Animal Kingdom. Danbury Press.

The New International Wildlife Encyclopedia. Burton - NCLS Limited.

Bibliography

Magazine Articles

"Endangered Animals". Classmate. April-June 1986.

"Extinct is Forever". Instructor. April 1986.

Pamphlet

"Endangered Species". North Carolina Zoological Society, Incorporated.